Materials & Methods

Selection & use of

metals, nonmetallics, parts, finishes,

in product design & manufacture

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Nickel Silvers—M & M Manual No. 133

New Leaded Steels

Protecting Molybdenum at High Temperatures

Selecting Nickel Alloy Wire

Acrylic Coatings for Metal Products

Treated Felts

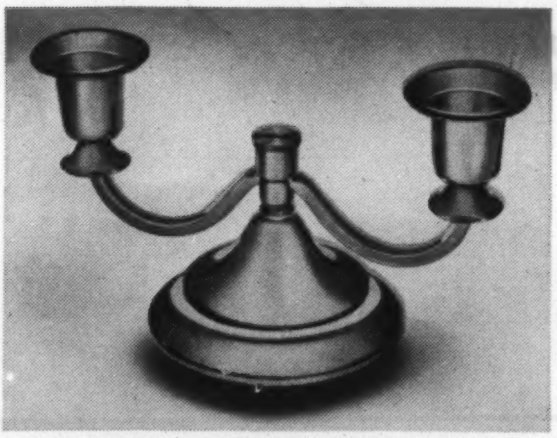
Get More Out of Beryllium Copper

Complete Contents—page 1

RICE FIFTY CENTS

THE BASE of a Huntercraft Candelabra Model 8008 (shown below) requires, with Formbrite, only a finish buff. The base is formed in two drawing operations. The deeper drawn candle cups, also of Formbrite, need only a light cutting with Tripoli and a finish buff.

It's easy to get a jeweler's finish with Formbrite



HUNTERCRAFT Table or Wall Candelabra Model 8008, one of 30 fine brassware items in the line of Huntercraft Originals.

"Formbrite cut polishing cost and time dramatically—was a major factor in keeping our small business alive . . . and growing," says Ralph E. Hunter of Huntercraft.

The production of Huntercraft Originals—now a nationally distributed line of fine brassware—has grown from a basement hobby to a thriving new business in less than 5 years.

The Hunter Machine Service Company of Racine, Wisc., began manufacturing Huntercraft Originals on a commercial scale in 1951, using ordinary soft forming brass. To get the gleaming jeweler's finish required, polishing time and costs were high. In fact, they were so high that the young company found it impossible to bring their prices into line with competition.

In 1953, they tried Formbrite®, Anaconda's superfine-grain drawing brass. The polishing bottleneck was broken and production soared – unit costs went way down. According to Ralph E. Hunter, owner and president of Hunter Machine Service Co., Formbrite was a major factor in keeping the company alive and enabling it to go on to become a stable, growing business. The finish obtained so easily on Formbrite, he adds, is superior to that achieved on ordinary drawing brass.

Formbrite is a premium product at a nonpremium price. Find out for yourself how its superfine-grain, excellent drawing properties, strength, and scratch-resistance can help you make a better product at lower cost. Write for Publication B-39. Better yet, ask for a sample or a trial batch. Address: The American Brass Co., Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

Formbrite SUPERFINE-GRAIN DRAWING BRASS

an ANACONDA® product

made by The American Brass Company

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INCO Nickel Alloys

TRADE MARK

In wrought Inconel "Neu-pot", KLK Manufacturing Company, Logansport, Indiana, treats small parts faster. For information about the "Neu-pot" write Rolock, Inc., Fairfield, Connecticut.

Treated in wrought Inconel pots, these small parts cost less

volume goes up, pot replacement down

These parts are done to a turn . . . in nice time, at low cost.

That's because the salt bath is contained in a Rolock "Neu-pot" made of wrought Inconel* nickel-chromium alloy.

KLK Manufacturing Company reported that unlike most "pot" materials, Inconel alloy retains original heat transfer characteristics throughout its useful service life. With it, loads can be hurried along as rapidly as good practice permits. Volume goes up, cost per piece down.

Long pot life lowers cost, too

In this installation, KLK goes on to say, Inconel nickel-chromium alloy also substantially increases pot life. They report that former pots gave, at best, only six weeks service. Their first Inconel "Neu-pot" lasted almost 5 times longer.

In overall pot expense KLK saves 50 percent by using wrought Inconel alloy. The company also realizes a major reduction in down-time. Both savings are reflected in the cost per piece.

Is high sustained heat, or heat plus severe corrosive conditions your problem? If so, look into Inconel. Write for the Inco booklet, "Keep Operating Costs Down As Temperatures Go Up."

*Registered Trademark

The International Nickel Company, Inc.
67 Wall Street New York 5, N. Y.

Inconel *. . . for long life at high temperatures*

For more information, turn to Reader Service Card, Circle No. 551

Materials Outlook

A MODIFIED POLYETHYLENE shows remarkable improvements in physical properties after radiation treatments. Degree of property improvement is said to be greater than that obtained by irradiation of unmodified polyethylene. As wire insulation — the only form in which it is currently available — the plastic can be dipped in molten solder at 600 F without being affected. A high-density polyethylene modified and irradiated by the new process will soon be available.

NEED FOR CREEP TESTS MAY BE ELIMINATED by new parameters providing a direct relationship between hot hardness and creep and stress-rupture properties. Not yet published, these parameters are said to hold up well for relatively pure metals. Now it must be determined whether they also hold for the more complex high temperature alloys.

A NEW ALUMINUM BRONZE ALLOY containing about 12% manganese will soon be produced in this country. Developed in Great Britain, the alloy reportedly has outstanding castability. Other design advantages over conventional aluminum bronzes include lighter weight and improved strength.

NEW ALLOYS WITH A TUNGSTEN BASE have been developed to the point where sample turbine blade castings are being produced. With melting points and recrystallization temperatures appreciably higher than those of present nickel- and cobalt-base superalloys, they reportedy withstand operating temperatures hundreds of degrees higher than can now be tolerated.

METAL PIPING LINED WITH SINTERED BASALT — a constituent of volcanic rock with a Mohs hardness of 8 to 9 — is a product of Czechoslovakia that may soon be available here. The basalt is fused to the inner surface of the pipe to provide extreme resistance to abrasion, acids and other chemicals. The material is also produced in slabs, bricks and special shapes.

A "BOILABLE" THERMOPLASTIC SHEET, a modification of existing styrene-acrylonitrile-butadiene blends, has been developed. The calendered sheet has a heat distortion point (246 psi) of 215 F — about 30 degrees higher than previous grades. According to present plans, the sheet will also be available with thin overlays of a new grade of copolymer blended sheet which resists water spotting.

SILVER PLATING OF COPPER WIRE by a new low current density process is said to result in a remarkable degree of adhesion and in uniformity of thickness within 1%. The high adhesion allows the

Materials Outlook

wire to be finely redrawn, yet maintain its original proportion of thickness.

ALUMINUM ALLOY HAND FORGINGS can now be produced with low internal stress, reducing machining and straightening time, as the result of a new tempering process. The process may be adaptable to the stress relief of die forgings if current investigations pan out.

NEWEST OF THE FLUORINATED ELASTOMERS — a linear copolymer of vinylidene and hexafluoropropylene — produces vulcanizates that are strong and elastic after prolonged exposure to air, oils and corrosive chemicals near 600 F. Still in the development stage, the elastomer has ozone resistance and weathering properties that make it promising also for low temperature applications.

A NEW HIGH STRENGTH ZIRCONIUM ALLOY (4% tin, 1.6% molybdenum) can be readily rolled at 1470 F and has four times the creep strength of pure zirconium at 930 F. The alloy can be heat treated to a strength of 140,000 psi, is harder air quenched than water quenched.

THE NEW LINEAR POLYMERS are being studied for use as tire yarns. Polyethylene and isotactic polystyrene, polypropylene and polybutylene (melting points from 266 F to 450 F) can all be meltspun and, by appropriate drawing, given substantial tenacities. Simple treatments introduce enough amino groups to facilitate curing and adhesion to rubber.

ALUMINUM-TIN ALLOY STRIPS can now be bonded to steel strips for automobile shell bearings without the preparatory step of aluminizing the steel. The bonding is done by rolling under pressure until the composite strip is reduced 50% in thickness. Process may be carried on at room temperature, but is more effective at about 400 F.

STRONGER ENGINEERING MATERIALS may have been brought closer by a new technique for observing the motion of dislocations — the defects responsible for weakness — that occur in crystalline materials such as metals and ceramics. The technique involves the use of an etching solution and crystals of lithium fluoride.

A HEAT-SEALABLE POLYESTER FILM can be used to protect documents and instruction sheets. Paper is sandwiched between two layers of film and by use of heat and slight pressure, the polyester impregnates the paper. Film provides chemical and weathering resistance, as well as strength.

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Students and foreign subscribers (other than Canadian), please request literature directly from manufacturers.

MANUFACTURERS' LITERATURE

New Literature

Steel Rings. Alco Products, Inc., 16 pp, illus. Handy chart showing, in 8-in. divisions, weights for rings from 1 to 145 in. overall dia. Shows the company's manufacturing facilities and gives applications for ring forgings. (1)

Tool Steels. Allegheny Ludlum Steel Corp., 204 pp, illus. Latest information on tool steels. Data on types, properties and applications. Chapters are devoted to such items as: selecting the proper steel; tool steel products; and working tool and high speed steels. Also contains reference tables. (2)

Aluminized Wire. American Chain & Cable Co., Inc., Page Steel & Wire Rope Div., 6 pp, illus., No. DH-537. Describes the company's line of aluminized products and gives physical properties and miscellaneous applications involving corrosion and high operating temperatures. (3)

Testing Machine. Riehle Testing Machines Div., American Machine & Metals, Inc., 8 pp, illus., No. RR-13-56. Describes a testing machine for creep and stress-rupture tests. (4)

Welding. Babcock & Wilcox Co., Tubular Products Div., 12 pp, illus., No. TR-543. "Heat Treatment of Air Hardening Alloys on Welding," which appeared in the Oct '55 *Welding Journal*. Data on postweld heat treatment and the influence of weld preheating temperature on hardness and microstructure of heat treated welds of air hardening alloys. (5)

Rhodium Electroplating. Baker & Co., Inc., 20 pp, illus. Shows applications of rhodium plating and discusses physical properties of the metal. Gives a step-by-step procedure for rhodium plating. Table lists physical properties of the metals of the platinum group. (6)

Nickel-Lined Pipe. Bart Mfg. Corp., 8 pp, illus. Gives fabrication techniques and information on applications of nickel-lined pipe and fittings in the paper, chemical, pharmaceutical and food industries. (7)

Investment Casting. British Industries Corp., 28 pp, illus. Contains a complete review of the development, operation and application of a new investment casting process. Write to Dept. PR-10, Shaw Process Development Corp., 80 Shore Rd., Port Washington, N. Y.

Wood Adhesives. Catalin Corp. of America, 8 pp, illus. Information on urea, modified urea, phenolic and resorcinol wood adhesives. Discusses formulation, mixing, spreading, assembly time, temperature, pressure and cure time. Brief discussion of the moisture content of wood to be bonded. (8)

Teflon Products. Chicago Gasket Co., 4 pp. Description of the uses, specifications, applications and properties of Teflon tape, cementable and plain Teflon sheets, plain and cementable Teflon-coated fiberglas, Teflon rods, tubes and cements. (9)

Induction Hardening. Cincinnati Milling Machine Co., 4 pp, illus. Describes an induction hardening machine, outlining its operation with respect to tool changes, maintenance, installation and machine life. Includes specifications. (10)

Printing Inks. Claremont Pigment Dispersion Corp., 2 pp, No. 345. Lists properties and uses of the company's line of printing inks designed for decorating treated polyethylene film. Gives shipping information on color, price, packing and delivery. (11)

Cap Screws. Cleveland Cap Screw Co., 4 pp, illus. Describes cap screws made of heat treated alloy steel in sizes from 4 to 1½ in. Also listed are button head socket screws, shoulder screws, pressure plugs and hex socket screw keys. (12)

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Special Alloys. Niagara Falls Smelting & Refining Div., Continental Copper & Steel Industries, Inc., 6 pp. Information on aluminum bronze hardeners, boron manganese aluminum alloy, 50-50 nickel copper alloy, and chromium-aluminum and vanadium-aluminum alloys. (13)

Lock Fasteners. Continental Screw Co., 4 pp, illus. Application data on various sizes and shapes of Nylok self locking screws and bolts for such products as lawn mowers, faucets, door handles and washing machines. (14)

Chromium Plating. Dawson Corp., 4 pp, illus. Describes the Riedel barrel chromium plater which is said to plate 8 to 10 lb of material every 5 to 10 min. (15)

Contacts, Rivets. Deringer Metallurgical Corp., 4 pp, illus. Lists 300 standard electrical contacts and rivets available in silver, gold, platinum, palladium, brass, steel, aluminum, copper, and precious and base metal alloys. (16)

Weldments. Dresser Mfg. Div., Dresser Industries, 8 pp, illus. Shows various types of weldments and rings manufactured by the company. Principles of flash welding, along with cross section photos of flashwelds on various metals, are also given. (17)

Chemical Resistance of Rubber. E. I. du Pont de Nemours & Co., Elastomers Div., July '56 *Neoprene Notebook* No. 70, tells how the rubber industry tests and evaluates chemical properties of elastomers. (18)

Titanium Organics. E. I. du Pont de Nemours & Co., Pigments Dept., 8 pp. Contains information relating to the use of titanium esters, titanium chelates and titanium acylates. Suggested applications for titanium organics includes coatings and heat resistant paints. (19)

Plastics Fabrication. Durable Formed Products, Inc., 16 pp, illus. Information on the fabrication of Plexiglas, Boltaron, Royalite and Styron by vacuum forming. Data on low pressure molding of glass-reinforced polyester. (20)

Laminated Plastics. Formica Co., 20 pp, illus. Lists composition, and physical and dielectric properties of Formica laminated plastics. Discusses use of copper clad laminates for printed circuits. A comparator chart helps in the selection of the proper laminate for a particular application. (21)

Refractory Products. J. H. France Refractories Co., 4 pp, illus, No. 200. Seven technical data tables on the company's firebrick, Corindon brick; refractory, insulating and special castables; high temperature mortars and plastic firebrick. Product applications are included. (22)

Phenolic Compound. General Electric Co., Chemical Materials Dept., illus., No. CDC-324. Automatic molding applications of GE's one-stage phenolic molding compound, G-E 12902, are described. Curing characteristics and other technical data are given. (23)

Silicone Selector. General Electric Co., Silicone Products Dept., 4 pp, illus., No. AA 24 E. Lists major categories and properties of silicone compounds. Cross references to AMS and ASTM specifications are included. (24)

Metal Fabrication. Grotnes Machine Works, 20 pp, illus. Information on the Grotnes method of expanding, shrinking and rolling metal. How the method started; its principles and practice; and how it is used in industry. (25)

Fasteners. H. M. Harper Co., 24 pp, illus., No. 613. Dimensional and application data on special fasteners. Case histories of parts redesigned by Harper show engineering drawings. (26)

Polyester Resins. Interchemical Corp., Finishes Div., 8 pp. Summary of physical properties and suggested end uses of rigid, resilient, flexible, low volatile and nonvolatile, and fire retardant polyester resins and accessory products. (27)

Weld Deposit Study. International Nickel Co., Inc., 7 pp, illus. Reprint from June '56 *Welding Journal* showing results of impact and fatigue strength tests conducted on low alloy nickel-molybdenum-vanadium weld deposits in the as-welded, stress relieved, quenched and tempered, and annealed conditions. (28)

Steel Tubing. Jones & Laughlin Steel Corp., 4 pp, illus. How cold drawn Electricweld steel tubing is made. Shows applications of the tubing in various parts and assemblies. Gives specifications and discusses chemistry, mechanical properties, annealing and finish of the product. (29)

Aluminum Wall Chart. Kaiser Aluminum & Chemical Corp., 4 pp, illus. Wall chart identifying Aluminum Assn. color codes for 32 aluminum rod, bar and wire alloys. Can also be inserted in a three-ring binder. (30)

Metal Powder Bearings. Keystone Carbon Co., 30 pp. Catalog on plain, flanged and spherical bearings and thrust washers; and cored and solid bars and plates. Gives diameters and lengths. (31)

Microlite Insulation. L. O. F. Glass Fibers Co., 4 pp, No. WML-5. Thermal and acoustical performance charts. Gives a brief description of how Nicrolite is made, and what it is made of. Application data for heating and air conditioning systems, mobile homes and appliances. (32)

Casting Design. Meehanite Metal Corp., 64 pp, illus. Information on certain basic fundamentals of casting design and how they are influenced by foundry practice. Discusses pattern making, and the nature, behavior and characteristics of the metal in the mold. (33)

Cobalt. Metallurgical Resources, Inc., 8 pp, illus. Discusses the use of cobalt alloys in atomics, automation and aviation. Gives a brief history of the uses of the material and discusses its manufacture and consumption. (34)

Splicing Kit. Minnesota Mining & Mfg. Co., 4 pp, illus., No. 90-B1. Instructions and application information for "Scotchcast" brand splicing kit. A chart outlining the electrical and physical properties of "Scotchcast" epoxy resin is included. (35)

Barrel Finishing. Norton Co., 76 pp, illus., No. 501. Information on types of barrels, selection of abrasives, cleaners, time cycles and other facts about barrel finishing. Case histories of deburring, finishing for plating and forming of radii to blueprint specifications. (49)

Tubing Data. Parker Appliance Co., Tube & Hose Fittings Div., 8 pp, illus., No. 4305. Charts and tables to aid in proper selection of tubing—size, wall thickness and material—for various operating conditions. Factors considered are flow requirement, pressure, severity of service and temperature. (36)

Vinyl Electrical Tapes. Permacel Tape Corp. Describes the qualities and applications of electrical pressure-sensitive tapes made of a specially formulated vinyl. (37)

Pressure-Sensitive Adhesive. Pierce & Stevens Chemical Corp., 2 pp. General description of a pressure sensitive adhesive, called C-9199. Gives application data and information on coverage, storage, handling and safety precautions. (38)

Plastics Laminate. Russell Reinforced Plastics Corp., 1 p. Physical and electrical properties of two grades of glass fiber-polyester laminates. Lists color, sheet sizes, thickness and weight per sq ft. (39)

Metal Stampings. J. H. Sessions & Son Co., 4 pp, illus. Designed to slip into a file drawer, folder contains information on standard and special metal stampings, and assemblies for finished products. Describes stamping facilities available at the company. (40)

Stainless Steel Tubing. Superior Tube Co., 3 pp, illus., No. 2. Describes Weldrawn tubing. Sizes are listed in a table of analyses and production limits. A photomicrograph shows juncture of parent metal and weld area in the tubing. (41)

Bolts, Nuts, Screws. Sterling Bolt Co., illus. Purchasing data on bolts, nuts, screws, washers and miscellaneous metal fasteners. Gives standards, weights and design information (42)

Tin. Tin Research Institute, 16 pp, illus., No. 36. Contains articles on tinplate and canning, soldering, bearing alloys and organotin compounds. Includes an article on "Speculations on the Future of the Tinplate Container." (43)

Pipe Insulation. Union Asbestos & Rubber Co., 40 pp, illus., No. 904. Reference guide for pipe insulation materials. Special index helps to determine proper insulation thickness. Drawings show how "Unibestos" insulation is applied to pipe bends, flanges, valves and fittings. Charts and tables list physical and thermal characteristics. (44)

Cast Iron Addition. Metallurgical Div., Union Carbide & Carbon Corp., 16 pp,

Manufacturers' Literature

illus. How to inoculate irons with "SMZ" alloy to reduce chill depth and improve machinability, tensile strength and transverse properties. The alloy is a graphitizing inoculant containing silicon, manganese and zirconium. (45)

Small Metal Tubing. Uniform Tubes, Inc., 4 pp, illus. Information on small seamless tubing for electrical and mechanical measuring instruments and other applications. Tubing is available in aluminum and copper alloys, stainless steel, nickel alloys, low carbon steel, nickel silver and phosphor bronze. (46)

Aluminum Tube. United Wire & Supply Corp., 4 pp, illus. Discusses the application of aluminum tubes in the furniture industry. Outlines United facilities, and includes tables of both mechanical and chemical properties. (47)

Fasteners. Vibrex Fastener Corp., illus. Describes different types of vibration-isolating fasteners, together with tensile strength, sealing and anti-vibration characteristics. Applications include instrument mounting and panel fastening for metal and plastics. (48)

Other Available Literature

Irons & Steels • Parts • Forms

Colored Stitching Wire. Acme Steel Co., 1 p. Selection guide for colored stitching wire. Colorstitch has a tough vinyl paint finish that resists chipping and peeling. (51)

Stainless Steel Rings. Advanced Products Co., 4 pp, illus. Properties of Metal "O"-Rings for static sealing. (52)

Aluminum, Stainless Steel. Aluminum Goods Mfg. Co., Contract Div., 21 pp, illus. Lists wide variety of component parts made for government and industry. Technical services and finishing and fabricating facilities are also described. (53)

Low Alloy Steel. Bethlehem Steel Co., 66 pp, illus., No. 353. Properties and features of Mayari-R steel for use in applications requiring high strength and good wear and corrosion resistance. (55)

Alloy Tubing. Bishop & Co. Platinum Works, Stainless Steel Products Div., 12 pp, illus. Catalog of cold drawn stainless steel tubing—mechanical capillary and hypodermic. Also describes nickel and nickel alloy tubing. (56)

Alloy Sheet Metal Parts. S. Blickman, Inc., Weehawken N. J., 29 pp, illus. Guide for purchasing alloy sheet and light plate fabrication. Request from S. Blickman on company letterhead.

Bar Steels. Bliss & Laughlin, Inc., 4 pp, illus., No. 55. How Strain-Tempered bar steel improve products and reduce costs. Typical applications include shift spur gears, main drive splines, machine shafts and snapping roll drives. (57)

Ferrous Castings. Campbell, Wyant & Cannon Foundry Co., 24 pp, illus. Describes facilities for producing gray iron and steel castings, and pictures a variety of actual production parts. (58)

Alloy Comparison Chart. Cannon-Muskegon Co. Comparison chart of AISI, SEA, ACI. AMS, WAD and PWA alloy specifications. (59)

Molybdenum in Cast Iron. Climax Molybdenum Co., 8 pp, illus., Nos. 1, 2. Case histories on the use of molybdenum as an alloying element in gray iron castings. Tabulates the effect of adding different alloys to a single base iron and shows the advantages of molybdenum. (60)

Steel Tubing. Summerill Tubing Co., Div. Columbia Steel & Shafting Co., 8 pp, illus. Cold drawn steel tubing for hydraulic applications. (61)

Steel Sheets and Wire. Continental Steel Corp., 20 pp, illus. Contains sizes, tempers, shapes and finishes of wire available and describes types of steel sheet in stock (62)

Lead Treated Steel. Copperweld Steel Co., Steel Div., 8 pp, illus. Mechanical properties and applications of lead treated steels. (63)

Tool Steel. Crucible Steel Co., 47 pp, illus. Presents a practical understanding of tool steels in monmetallurgical terms. Discusses water and oil hardening steels, hot working steels and high speed steels. (103)

Metal Stamping. Dayton Rogers Mfg. Co., 23 pp, illus. Describes a small lot metal stamping service "with lowest possible die costs." (64)

Die Casting. Dollin Corp., 16 pp, illus. Booklet describes plant and facilities for die castings. (65)

Shell Mold Castings. Electric Steel Foundry Co., 12 pp, illus., No. 205. Describes advantages of shell mold castings and illustrates castings made for various industries. (66)

Carbonyl Iron Powder. Antara Chemicals, Div. of General Aniline & Film Corp., 8 pp. Data on ten types of carbonyl iron powder. Includes graphs on properties. (67)

Steel Tubing. Rochester Product Div., General Motors Corp., 12 pp, illus., No. 271. Typical applications of GM tubing made in both single and double walls of steel. (68)

Cast Iron Specifications. Gray Iron Founders Society, Inc., 4 pp. "Summary of Cast Iron Specifications." Covers gray and nodular (ductile) cast irons and cast pressure pipe, soil pipe, valves and fittings. (69)

Iron Powder. Hoeganaes Sponge Iron Corp., 4 pp. illus. Advantages of Ancor-Flame sponge iron powder in cutting, scarfing, gouging, lancing and washing. (70)

Investment Castings. Howard Foundry Co., 8 pp, illus. Description of the new design freedom obtainable through use of investment castings. (71)

Electrolytic Iron Powder. A. Johnson & Co., Inc., 30 pp, illus. Detailed account of a high purity powder with higher sintering activity, better compressibility, and a higher flow rate. Made in Sweden. (72)

Sheet and Plate Fabrication. Kirk & Blum Mfg. Co., 38 pp, illus. Describes facilities and equipment used in production of metal sheet and plate (73)

Stainless Steel Castings. Kolcast Industries, Inc., 4 pp, illus. Shows large stainless steel precision castings made by the frozen mercury process. (74)

Weldless Rolled Rings. Ladish Co., 4 pp, illus. Advantages and applications of high strength weldless rolled rings produced in weights up to 20 tons. (75)

Ceramic Mold Castings. Lebanon Steel Foundry, 4 pp, illus. Process for producing close tolerance steel castings from ceramic molds. (76)

Wire Gage Chart. Little Falls Alloys Inc. Chart for determining gage and footage readings in Brown & Sharpe (AWG) wire gages. (77)

Ductile Iron Castings. Lynchburg Foundry Co., 12 pp, illus. Describes ductile cast iron with detailed description of its properties and suggests application. (78)

Welded Assemblies. R. C. Mahon Co., 1 p, illus. Several examples show the capabilities of welding for construction of various assemblies. (79)

Seamless Mechanical Tubing. Pittsburgh Steel Co., 198 pp, illus. Applications, cost analysis, production techniques, inspection and testing methods tolerances, chemical composition, physical properties, machining techniques and reference tables for full range of seamless mechanical tubing. (80)

Iron Powder. Pyron Corp., 8 pp, No. 1. Technical information on hydrogen reduced and electrolytic iron powders. Sintering data, effect of infiltrants, dimensional stability, strength, etc. (81)

Stamping and Perforating. Standard Stamping & Perforating Co., 114 pp, illus. Catalog of standard stamped and perforated patterns. (82)

Malleable and Alloy Iron Castings. Texas Foundries, Inc., 20 pp, illus. Describes foundry facilities and provides case histories of applications of malleable iron. (84)

Wire Construction. E. H. Titchener & Co., 11 pp, illus. Study of 36 case histories shows how wire in product design cuts costs. (85)

Stainless and High Alloy Tubing. Trent Tube Co., 48 pp, illus. Classifies types of tubing, giving applications, physical, chemical and electrical properties for each. Welding, bending and installation techniques. (86)

Manufacturers' Literature

Super Alloys. Universal-Cyclops Steel Corp., 20 pp, illus. High strength, corrosion resistant alloys for gas turbines, turbo-superchargers rockets and guided missiles. (87)

Weldments. Van Dorn Iron Works Co., 10 pp, illus. Facilities for producing weldments and other parts in all sizes. Examples show type of work done. (88)

Stampings. Variety Machine & Stamping Co., 4 pp, illus. Describes plant facilities and types of stampings produced. (89)

Steel Strip. Weirton Steel Co., 20 pp, illus. Characteristics of electrolytic zinc coated sheets and strip, high tensile steel and high carbon strip cold-rolled spring steel manufactured by Weirton. (90)

Nonferrous Metals • Parts • Forms

Die Castings. Advance Tool & Die Casting Co., 8 pp, illus. Illustrates facilities for producing die casting to specifications. (94)

Precision Parts. Aero Supply Mfg. Co., Inc., 8 pp, illus. Describes facilities for design and production of precision parts on contract basis. Lists work and size capacities and shows sample varieties. (95)

Metal Products. Allied Metal Specialties, Inc., 4 pp, illus. Illustrates a variety of trays, racks, fixtures, tanks, crates, baskets, etc. produced by this company. (96)

Aluminum Design Manual. Aluminum Co. of America, 32 pp, illus. Describes Alcoa impacts and their method of fabrication—impact extrusion. Process produces hollow cup-shaped shells, flanged or cupped-end tubes, solid shapes and combinations of these forms at high production speeds and low cost. (97)

Bronze Electrodes. Ampco Metal, Inc., 4 pp, illus., No. W-25a. Applications, characteristics, properties and sizes of Ampco-Trode electrodes; Phos-Trode; Ampco-Trode Filler Rod and Coiled Wire; and Ampco-Braz No. 1 and 3. (98)

Duplex Tubing. Bridgeport Brass Co., 14 pp, illus., No. 1954. Explains use of Duplex tubes for heat exchangers and condensers in which internal and external corrosion conditions differ. (99)

Drawing Titanium. Brooks & Perkins, Inc., 6 pp, illus. Reprint discusses techniques for drawing and other forming methods used in making draws of unusual severity and depth. (100)

Low Melting Alloys. Cerro de Pasco Corp., 4 pp. Lists 63 known applications—most of them in the metalworking field—for Cerro nonshrinking, low melting alloys. (101)

Copper and Brass. Copper & Brass Research Assn., 16 pp, illus. *Copper & Brass Quarterly* covers selected applications. (102)

Resistance Alloys. Driver-Harris Co., 8 pp, illus. Four bulletins describe an 0.0005-in. dia enamelled wire for resistors; an alloy with a specific resistance of 1000 ohms per cmf; a new heating element alloy; and a new oxidation resistant, thermocouple for high temperatures. (104)

Investment Castings. Engineered Precision Casting Co., 8 pp, illus. Complete data on EpCo precision investment castings of stainless steel, alloy tool steel, beryllium copper and other metals and alloys. (105)

High Density Metal. Fansteel Metallurgical Corp., 16 pp, illus. Properties and uses of Fansteel 77 Metal. This machinable tungsten-copper-nickel alloy is used for counterweights, flywheels, vibration damping and radiation shielding devices. (106)

Aluminum Alloy. Frontier Bronze Corp., 24 pp, illus. Describes Alloy 40-E, a high strength alloy containing zinc, magnesium, titanium and chromium. Alloy needs no heat treatment. (107)

Metal Powder Parts. Globe Industries, Inc., Supermet Div., 8 pp, illus. Design information on Supermet powder metal process. Powder metal parts can be made to the same or in many cases lower tolerance margins than machined parts. (108)

Brass. Hampden Brass & Aluminum Co., 262 Liberty St., Springfield, Mass., 24 pp, illus. Describes manufacturing facilities of the company and of the Fibermold Div., which makes reinforced plastics. Request from Hampden on company letterhead.

Perforated Metal Sheets. Harrington & King Perforating Co., Inc., 6 pp, illus. Describes sizes, gages and materials of perforated metal sheets carried in stock. Patterns are shown at actual size. (109)

Screens, Fabricated Metals. Hendrick Mfg. Co., 132 pp, illus. A 75th anniversary catalog on perforated metals, screens and fabricated metals. Typical uses, designs, sizes and engineering data. (110)

Laminated Metals. Improved Seamless Wire Co., Inc., 6 pp, illus. Describes applications of laminated metals in modern industry. (111)

Beryllium Copper Springs. Instrument Specialties Co., Inc., 16 pp, illus., No. 9A. Data on precision beryllium copper springs. Shows typical compression, flat and strip springs and contact strips and rings. (112)

Wire. Keystone Steel & Wire Co., 12 pp, illus., No. 1a Ke. Illustrates the various kinds of wire available and provides information about the cold heading operation. (113)

Stampings. Laminated Shim Co., Stampings Div., 12 pp, illus. Facilities for producing quality stampings to specifications and ordering data. (114)

Tin. Malayan Tin Bureau. *Tin News*, a monthly publication of the Malayan Tin Bureau, reviews market situation, tin uses and political developments affecting the supply of tin. (115)

To obtain literature listed on these pages, use the convenient prepaid post card on pp 67 and 68.

Die Castings. Monarch Aluminum Mfg. Co. File data on aluminum and zinc die castings and aluminum mold castings showing applications, advantages and facilities for making them. (116)

Precision Casting Process. Morris Bean & Co., 4 pp, illus. Describes Antioch process for producing castings that meet wave guide specifications in all bands. (117)

Copper Alloys in Rod Form. Mueller Brass Co., 28 pp, illus. Engineering data on copper base-alloys are given, together with description of new company facilities. (118)

Aluminum Core. Narmco Metlbond Co., 6 pp. Formable core material for aluminum sandwich constructions where small-radius curves are needed. (119)

Die Castings. National Die Casting Co., 8 pp, illus. No. 266. Describes die casting facilities. Data sheet on zinc and aluminum die casting alloys. (120)

Brass Powder Parts. New Jersey Zinc Co., 4 pp, illus. Outlines applications for brass powder sintered parts, emphasizing tripper flywheel in advanced-type camera. (121)

Wire Cloth Parts. Newark Wire Cloth Co., 8 pp, illus. Describes facilities for making wire cloth parts and assemblies. Shows wire cloth parts in fine, medium and coarse mesh and space cloth. (122)

Precision Castings. Ohio Precision Castings, Inc., 12 pp, illus. Shows numerous examples of brass, bronze, aluminum and beryllium copper plaster mold castings. (123)

Die Castings. Paramount Die Castings Co., 4 pp, illus. Describes facilities and services. Also shows representative aluminum, magnesium and zinc castings. (124)

Aluminum Castings. Permold Co., illus. Shows how continuous scientific control of aluminum casting quality saves time and money. (125)

Investment Casting Alloys. Precision Metalsmiths, Inc. Chart covers stainless, low alloy and tool steels, nickel alloys, copper-base alloys and aluminum alloys. Complete chemical analysis and mechanical properties given. (126)

Precision Metal Parts. REF Mfg. Corp., 10 pp. illus. Facilities for producing precision parts and assemblies for aircraft and electronic use. (127)

Aluminum, Magnesium Castings. Rolle Mfg. Co., 58 pp, illus. Guide to design and specification of aluminum and magnesium sand, permanent mold and die castings. Discusses advantages and disadvantages of casting methods and gives properties of common aluminum and magnesium casting alloys. (128)

Aluminum Strip. Scovill Mfg. Co., 20 pp, illus. Physical characteristics, temperature designations, weights and fabricating data for aluminum alloy strip. (129)

Aluminum Castings. Solon Foundry, Inc., 4 pp, illus. Description of company's plant and facilities for producing aluminum castings. (130)

Manufacturers' Literature

Wire Processing. Sylvania Electric Products, Inc., Parts Div., 12 pp, illus. Facilities for manufacture of fine wire and ribbon, and wire and ribbon parts. Chemical composition charts of materials used are included. (131)

Electronic Materials. Sylvania Electric Products, Inc., Tungsten & Chemical Div. Series of data sheets on tungsten, molybdenum, semiconductor, plated wire, chemical and phosphor products. (132)

High Temperature Alloy. Haynes Stellite Co., Div. of Union Carbide & Carbon Corp., 12 pp, charts. Data on Hastelloy alloy R-235, a wrought, nickel base, aluminum and titanium-bearing, precipitation hardening alloy. Available as sheet, plate, bar stock, tubing, wire and billets for forging. (133)

Precision Castings. Universal Castings Co., 4 pp, illus. Technique of pouring at low temperatures and under vacuum as used in casting precision impellers. (134)

Sintered Bearing Alloys. U. S. Graphite Co., Div. of Wickes Corp., 6 pp, illus., No. 18. Discusses design and metallurgical requirements for selection of sintered metal bearings. (135)

Nonmetallic Materials • Parts • Forms

Nylon Molding Compounds. Barrett Div., Allied Chemical & Dye Corp., 4 pp, illus. Molding characteristics and physical properties of Plaskon molding compounds and Plaskon polyethylene lubricants. (139)

Plastic Pipe. Alpha Plastics, Inc., 10 pp, illus. Applications, sizes, properties, and fittings of PVC corrosion resistant pipe. (140)

Plastics vs Reagents. American Agile Corp. Compatibility or noncompatibility of reagents with such thermoplastic materials as polyethylene unplasticized polyvinyl chloride, high impact polyvinyl chloride and high tensile, high temperature polyethylene. (141)

Extruded Plastics. Anchor Plastics Co., 12 pp, illus. Applications of thermoplastic rods, tubes and shapes. Summary of properties of plastics materials with usage table. (142)

Fiberglass-Reinforced Plastics. Apex Electrical Mfg. Co., 4 pp, illus. Case histories of custom molded fiberglass parts, featuring pressure vessels. (143)

Nonmetallic Linings. Automotive Rubber Co. Eleven actual specimens of rubber and plastics compounds used in most corrosion and abrasion resistant lining work done by this company on tanks, vessels, pipe, fittings, duct work, fans and other equipment. (144)

Thermoplastics. Bassons Industries Corp., 12 pp, illus. Complete data on reinforced and formed plastics. Illustrates processing facilities. (145)

Coated Abrasives. Behr-Manning Corp., 60 pp, illus. Discusses coated abrasive grinding and polishing techniques. Covers coated abrasives theory and practice, contour polishing and grinding, part sizing and deburring (146)

Nylon Resins. Belding Corticelli Industries, 17 pp. Technical bulletin on physical and chemical aspects of BCI 800 Series nylon. Product studies point up the series versatility and potential applications. (147)

Phenolic Resins. Borden Co., Chemical Div., 8 pp, illus. Durite phenolic molding compounds, bonding resins and impregnating resins. (148)

Bendable Tubing. Flexaust Co., Div. of Callahan Zinc-Lead Co., Inc., 4 pp, illus., No. 61. Describes Plica, a bendable tubing that can be bent by hand, cut with hacksaw or knife. Made in ferrous and nonferrous metals, fiber, paper and other materials. (169)

Decorator Flock. Cellusuede Products, Inc., 10 pp, illus. Describes flock, what it is, how it is used and how it is applied. (149)

Thermal Conducting Cement. Chemax Mfg. Corp., 10 pp, illus. Describes use of thermal conducting cements to improve heat transfer between tracing and process equipment. (150)

Resin - Bonded Laminates. Chemical Corp., 20 pp, illus., No. PD-1R353. Data sheets on a variety of tanks, ducts, hoods, stacks and waste pipe for corrosion resistant use. (151)

Compounded Elastomers. Chicago Rawhide Mfg. Co., 32 pp, illus. Characteristics, properties and engineering applications of Sirvene compounded elastomers. (152)

Fiberglass-Reinforced Parts. Clearfield Plastics, Inc., 22 pp, illus. Facilities for producing molded contoured parts. Suggests design and specification techniques. (153)

Plastics Properties Chart. Commercial Plastics & Supply Corp., 4 pp, illus. Chart showing mechanical, electrical, thermal and other properties of polyethylene methacrylate, polystyrene, nylon, Teflon, Vinylite and acetate. (154)

Extruded Plastics, Rubber. Conneaut Rubber & Plastics Co., 4 pp, illus., No. CR-53. Die making and production facilities for rubber and plastic extrusions. (155)

Molded and Extruded Rubber. Continental Rubber Works, 8 pp, No. 100. Dimensions of molded and extruded rubber with cross sectional illustrations. Also condensed SAE and ASTM specification chart. (156)

Teflon Products. Crane Packing Co., 12 pp, illus., No. T-110. Facts on Chemlon products made from Teflon. Describes packings, gaskets, O-rings, flexible bellows and sheets, rod tubing and tape. (157)

Urethane Foams. Dayton Rubber Co., 15 pp, illus. Describes flexible as well as rigid Poly-Koolfoam synthetics, which have excellent insulation properties and resist flame and chemicals. Also shows typical products and manufacturing facilities. (158)

Electrical Insulating Tapes. Dobeckmun Co., 4 pp, illus. Describes various electrical insulating tapes made from Mylar, cellulose acetate, cellulose acetate butyrate or cellulose triacetate bases, either alone or laminated. (159)

Thermoplastics. Dow Chemical Co., 20 pp, illus. Properties of forms of Styron, Ethocel, Saran and Vinyl supplied by Dow. Illustrates applications and outlines Dow's technical service facilities. (160)

Silicone-Glass Laminates. Dow Corning Corp., 4 pp, illus. Physical and dielectric properties of glass cloth laminates bonded with silicone resins. Also case history descriptions of a wide range of specific electric and electronic applications. (161)

Polyester Film. E. I. du Pont de Nemours & Co., Inc., Film Dept. Wilmington 98, Del. Convenient slide rule that compares the cost and properties of Mylar polyester film with those of other materials. Request from Du Pont.

Plastics for Lighting. E. I. du Pont de Nemours & Co., Inc., Polychemicals Dept., 11 pp, illus. Properties of Lucite acrylic resin and applications involving indoor and outdoor lighting. (162)

Plasticizer. Eastman Chemical Products, Inc., 6 pp. Describes plasticizer 84, a distilled butyl octyl phthalate plasticizer. for nitrocellulose lacquers. Tests show plasticizer to have excellent cold check resistance and permanence. (163)

Foam Vinyl. Elastomer Chemical Corp., 4 pp, illus. News Letter contains reports on new applications of Vinyl foam and lists its physical properties and advantages. (164)

Teflon. Ethylene Chemical Corp., 8 pp, illus. Complete data on a variety of molded and extruded Teflon parts, sheets, rods and tubing. Includes table of properties. (165)

Felt. Felters Co., 22 pp. Design properties, selection and applications of felt and felt products. (166)

Synthetic Rubber. Firestone Tire & Rubber Co., Synthetic Rubber & Latex Div. Information on FR-S, a new synthetic rubber developed by improved techniques, new measuring devices and scientific methods of control. (167)

Sintered Carbides. Firth Sterling, Inc., 4 pp, illus. Describes Firthite TXL, a carbide grade for machining steel. Contains a cutting speed vs tool life graph and performance reports. (168)

Laminating Materials. Flexfirm Products. A folder with seven technical bulletins, Nos. 1, 2, 3, 111, 112, 113, 105. Also fabrication instructions for polyester resin - impregnated glass cloth. (170)

Tooling Resins. Furane Plastics, Inc., No. EP-56-98. Chart listing basic information required in the selection of epoxy resins for tooling, casting, laminating and gel coating purposes. (171)

Plastics Products. General American Transportation Corp., Plastics Div., 10 pp, illus. Brochure shows plant facilities for production from blueprint through assembly and packing. Also lists wide variety of molded plastics. (172)

Coated Fabric. General Tire & Rubber Co., Textileather Div., 6 pp, illus. Introduces Nygen Tolex and nylon reinforced coated fabrics. (173)

Plastic-Faced Plywood. Georgia-Pacific

Manufacturers' Literature

Plywood Co., 14 pp, illus. Advantages of GPX plastic-faced plywood, used for cabinets, industrial counters, assembly line tables, etc. (174)

Polyethylene Tubing. Gering Products, Inc., 4 pp, illus. Describes Ger-Tube, a polyethylene tubing that is nontoxic and has good chemical resistance. (175)

Glass-Reinforced Plastic. Glastic Corp., 2 pp. Data on fiber glass reinforced polyester laminate sheets. (176)

Custom Made Rubber Parts. Goshen Rubber Co., Inc., 8 pp, illus. Representative products, fabricating operations and development of compounds. (177)

Investment Castings. Gray-Syracuse, Inc., 4 pp, illus. Parts of precision cast brass, bronze, beryllium copper and steel. (178)

Insulation Hardboard. Great American Industries, Inc., Rubatex Div., 16 pp, illus. Design data for building insulation applications of Rubatex Hardboard (expanded synthetic rubber compound). (179)

Insulating Material. Hays Mfg. Co., 12 pp, illus., No. 100. Properties of Haysite, a glass-reinforced alkyd base polyester insulating material designed to meet rigid electrical standards. (180)

Carbon and Rubber Products. Henrite Products Corp., 32 pp, illus. Gives information and data on typical company products in carbon and rubber fields. (181)

High Density Polyethylene. Hercules Powder Co., Cellulose Products Dept., 6 pp. Properties and uses of Hi-fax, a new high density polyethylene made by the Ziegler process. (182)

Structural Honeycomb. Hexcel Products Co. 32 pp, illus. No. C. Technical data on aluminum, glass fabric, stainless steel and cotton fabric honeycomb core for sandwich construction. (183)

Balsa Wood. International Balsa Corp., 19 pp. Factual report on balsa wood, its growth, production, processing and uses. (184)

Pipe and Block Insulation. Johns-Manville, 12 pp, illus. Describes Thermobestos pipe and block insulation made of hydrous calcium silicate. (185)

Industrial Tapes. Johns-Manville, Dutch Brand Div., 20 pp, illus. Shows the many uses of Dutch Brand industrial tapes and related products. (186)

Moldings and Panels. Keller Products, Inc., 21 pp, illus. Products for the building industry are described and data presented. (187)

Fluorocarbon Products. M. W. Kellogg Co., 8 pp, illus. Forms, properties and uses of Kel-F fluorocarbon products—plastic resins, dispersions, oils, waxes, greases, elastomers printing inks and chemicals. (188)

Electrical Tapes. Kendall Co., Polyken Sales Div., 4 pp, No. P6-1. Polyethylene, vinyl, plastic-coated cloth and cloth tapes for electrical applications. (189)

Adhesives. Koppers Co., Inc., Chemical Div., 8 pp, illus., No. C-6-230. Physical and chemical properties and various uses of resorcinol-formaldehyde compositions known as Penacolite Brittle Resins. (190)

Custom Glass. Lancaster Lens Co., 27 pp, illus. Catalog emphasizes design flexibility in glass. Shows lead glasses for electronics, heat resisting borosilicate glasses, lime glasses and many other special glasses. (191)

Vibration Control Materials. Lord Manufacturing Co., 12 pp, illus. Stock list of vibration control shock mounts and couplings. (192)

Plastics Moldings. P. R. Mallory Plastics, Inc., 4 pp, illus. Complete production facilities for large scale production of custom molded parts from design to finishing and assembly. (193)

High Impact Thermoplastic Resin. Marbon Corp., 20 pp, No. CY-2. Processing recommendations, physical data, chemical resistance data and results of aging tests for Cycolac, a resinous polymer in which the basic material is styrene. (194)

Insulating Material. Mica Insulator Co., Catalog of standard electrical insulating materials. (195)

Honeycomb Adhesives. Minnesota Mining & Mfg. Co., Adhesive & Coatings Div., 20 pp, illus. Data on adhesives for honeycomb structures. Discusses honeycomb sandwich materials, construction details and adhesive application procedures. (196)

Electrical Insulation. Minnesota Mining & Mfg. Co., Irvington Varnish & Insulator Div., Irvington, N. J. Loose leaf binder catalog of flexible electrical insulation materials. Includes charts and conversion tables. Request from Irvington on company letterhead.

Fiberglass-Reinforced Plastics. Molded Fiber Glass Co., 16 pp, illus. Describes custom molding services. Lists fabricating operations and mechanical electrical and chemical properties of molded fiberglass. (197)

Carbon Specialties. Morganite, Inc., 12 pp, illus. Design data reference for carbon specialties, including chemical and physical properties, and typical blank sizes and parts. (198)

Glass Bonded Mica. Mycalex Corp. of America, 24 pp, illus. Design information for parts to be machined from glass bonded mica. (199)

Foamed Plastic. Nopco Chemical Co. Suggested application of Nopco-foam, a flexible foamed plastic. (200)

Nonmetallics. Polymer Corp. of Pennsylvania, 4 pp, illus. Describes properties and characteristics of a line of nylon, Teflon and specialty nonmetallics. (202)

Carbon Graphite. Pure Carbon Co., Inc., 12 pp, illus., No. 55. Catalog on carbon graphite for mechanical applications. (203)

To obtain literature listed on these pages, use the convenient prepaid post card on pp 67 and 68.

Synthetic Rubber Compounds. Rubber & Plastics Compound Co., Inc., 4 pp, illus. Complete data on Nervastral Seal-Pruf, a synthetic rubber flashing and membrane waterproofing sheet, and Nerva-Plast, a cold setting waterproofing cement. (204)

Vulcanized Fibre Products. Spaulding Fibre Co., 36 pp, illus. Vulcanized fibre sheets, rods and tubes; fabricated parts; electrical insulating materials; laminated thermosetting plastics. Physical, mechanical and electrical properties of all materials in chart form. (205)

Fabricating Laminated Plastics. Taylor Fibre Co., 15 pp. Reprints of NEMA authorized engineering information, "Recommended Practice for Fabricating Laminated Plastics." (206)

Porcelain-Faced Plywood. U.S. Plywood Corp., 6 pp, illus. Describes Weldwood Porc-Lin-Ply panels. Shows colors available and gives typical applications, installation instructions and specifications. (207)

Synthetic Rubber Products. Western Felt Works, Acadia Synthetic Products Div., 6 pp, illus. Shows various types of molded, extruded, roll die cut and lathe cut synthetic rubber parts and sheets. (208)

Sealing Design. Franklin C. Wolfe Co., Inc., 4 pp, illus. Describes facilities and products for sealing bolts, studs, rivets and flanges. (209)

Finishes • Cleaning and Finishing

Prefinished Metals. American Nickeloid Co., 24 pp, illus. Describes fabrication techniques, uses and properties of prefinished metals. Also gives case histories of applications in various manufacturing fields. (213)

Chromate Sealer. Conversion Chemical Corp., No. P-40. How to use Kenvert No. 40, a chromate sealer for protecting aluminum against corrosion. (214)

Brush Plating. Dalic Metachemical, Ltd., 4 pp, illus. Presents advantages of brush plating with the Dalic process. (215)

Vinyl Lacquers. Davison Chemical Co., Div. of W. R. Grace & Co., 5 pp. Technical bulletin on use of Syloid 244 for flatting vinyl lacquers to give a low gloss effect. (216)

Vapor Spray Degreasers. Detrex Corp., 4 pp, illus. Open top degreasers for pure vapor degreasing, spray flushing with oil-free solvent distillate and final pure rinse. (217)

Aluminum Finishing. Diversey Corp.. 4 pp. Lists cleaning and finishing equipment for aluminum. (218)

Metallized Ceramic Coating. Frenchtown Porcelain Co., 4 pp, illus. Data on Molcote, metal-to-ceramic coating, that may be hard soldered up to 2200 F. (219)

Bright Nickel Plating. Harshaw Chemical Co., 4 pp, illus. Advantages of Nubrite bright nickel plating process. (220)

Metal Cleaner. Kelite Products, Inc., 2 pp, illus., No. 17-R. Degreasing and decarburizing agent. Formula 555, for aircraft and automotive parts. (221)

Manufacturers' Literature

Bright Copper Plating. Lea Mfg. Co., 22 pp. Technical manual on plating operations for bright copper coatings. Bath compositions and operating conditions given. (222)

Multicolor Enamel. Maas & Waldstein Co., 2 pp, No. 520. Data sheet for industrial multicolor enamels. (223)

Coatings, Adhesives. Magic Chemical Co. Catalog of Magic-Vulc protective coatings and Peerless industrial adhesives. (224)

Crack-Free Chromium. United Chromium Div., Metal & Thermit Corp., 4 pp, illus. No. CFC-1. Outlines properties of finishes obtainable with the new Unichrome, crack-free chromium plating process. (225)

Silicone-Base Finish. Midland Industrial Finishes Co. Brochure describes silicone-base finish, said to resist heat at 500 F without discoloration. (226)

Aluminum-Chromium Paint. Monroe Co., Inc., 4 pp, illus., No. C-54-8. Includes detailed application data on Monco-Alochrom, an aluminum-chromium paint for exterior and interior surfaces of all kinds. (227)

Micropolishing. Murray-Way Corp. Engineering specifications and auxiliary equipment needed for micropolishing. (228)

Phosphate Coating. Neilson Chemical Co., 4 pp, illus. Process for cleaning and phosphating metal surfaces for painting. (229)

Stripper. Northwest Chemical Co., 1 p. A liquid stripper to remove organic finishes from plastics. (230)

Rust and Paint Remover. Oakite Products, Inc., 2 pp. How Rustripper removes paint, phosphate coatings, rust and oil in one operation. (231)

Blast Cleaning, Dust Control. Pangborn Corp., 16 pp, illus., No. 226. Describes various models of "Continuous-Flo Rotoblast" barrels available for production line blast cleaning to reduce cleaning costs. (232)

Lubrication. Parker Rust Proof Co., 12 pp, illus. How Parco Lubrite reduces wear on bearing surfaces. (233)

Corrosion Proofing Materials. Pennsylvania Salt Mfg. Co., 8 pp, illus. Manual on corrosion proofing. Describes Corlok, a special silicate bonding material that resists sulfation and highly concentrated acids up to 1900 F for long periods. (234)

Fluorocarbon Resin Coatings. Permolite, Inc., 8 pp. Fluor-O-Alloy coatings based in trifluorochloroethylene polymer. Includes corrosion resistance data and application data. (235)

Coated Strip Steel. Thomas Strip Div., Pittsburgh Steel Co., 20 pp, illus., No. TS-101. Strip steel precoated with zinc, copper, brass, lead alloy, nickel or chromium. (236)

Polyvinyl Chloride Coatings. Quelcor, Inc., 4 pp, illus., No. 53A. Polyvinyl chloride coatings fused and flowed on metal for corrosion protection. (237)

Ceramic Coatings. Solar Aircraft Co., 8 pp, illus. Uses and properties of Solaramic coatings, a family of proprietary ceramic coatings designed to protect high or low alloy steel fabrications from heat and/or corrosion. (238)

Corrosion Resistant Coatings. Specialty Coatings, Inc., Div. of Thompson & Co., 6 pp. illus. How Vinsynite Pretreatment was used in finishing six different types of metal products for paint adhesion and corrosion resistance. (239)

Aluminum Coating. Turco Products, Inc. Information on an aluminum surface coating process that meets MIL-C-5541. Stops aluminum corrosion, insures paint adhesion and provides an ornamental finish. (240)

Methods & Equipment

Carbon Dioxide Welding. Air Reduction Sales Co., 13 pp, illus. Carbon dioxide shielded consumable electrode arc welding described with operating characteristics and specific properties. (244)

Brazing. All-State Welding Alloys Co., Inc., 51 pp, illus. Data for brazing shapes, sheet, castings, tubing and assemblies of copper, brass, steel, aluminum and cast iron. Also a buyers' guide. (246)

Brazing Rings. Alloy Ring Service, Inc., leaflet, illus. How to lower your costs, speed production and increase quality with precision rings and brazing preforms. (247)

Hardness Testing. Wilson Mechanical Instrument Div., American Chain & Cable Co., Inc., 12 pp, illus., No. DH-328. Describes Tukon Testers for micro and macro hardness testing that are used for testing metallic and nonmetallic parts. (248)

Precision Inspection Instrument. American Cystoscope Makers, Inc. Features and typical uses of ACMI borescopes for precision inspection. (249)

Environmental Test Equipment. American Research Corp., 6 pp, illus., No. 55-A. Discusses features, specifications and dimensions of equipment used for testing under conditions of altitude, temperature, humidity, sand and dust. (250)

Testing Machine. Baldwin-Lima-Hamilton Corp., 12 pp, illus., No. 4401. Hydraulic machines with capacities from 10,000 to 5,000,000 lb are described, including standard and special types of vertical and horizontal machines. (251)

Spectrograph. Bausch & Lomb Optical Co., 14 pp. Describes a 1.5-m stigmatic spectrograph for laboratory use. (252)

Metallurgical Testing Equipment. Buehler Ltd., 12 pp, illus. Describes metallurgical specimen mount presses. (253)

Parts Comparison. Caterpillar Tractor Co. Booklet compares parts available from machine manufacturer to those offered by substitute parts manufacturers. (254)

Rivets. Chicago Rivet & Machine Co., 16 pp, illus., No. 42. Catalog lists almost 1400 standard precision-made semitubular, full tubular and split rivets, and bag studs and rivet caps, contains chart of standard clinch allowances. (255)

Bolt and Forging Products. Columbus Bolt & Forging Co., 40 pp, illus. Describes facilities for producing assembly parts for the bolt and forging industries. (256)

Self-Locking Fasteners. Continental Screw Co., leaflet, illus. Features Holtite-Nylok screws and bolts. Nylon inserts in threaded section provide smooth, positive locking action. (257)

Sintering Furnaces. Drever Co., 12 pp, illus., No. B-101. Describes furnaces for sintering metal powder products. (258)

Lightweight Flexible Ducting. Flexible Tubing Corp., 4 pp, illus. Various types of lightweight flexible ducting engineered for air handling, fume removal, dust collection, and materials handling. (259)

Atmosphere Generators. Gas Atmospheres Inc., 6 pp, illus., Nos. N-452, 1-552. Describes features and applications of inert atmosphere generators and nitrogen atmosphere generators. (260)

Fasteners. General Tire & Rubber Co., illus., folder. Self-mounting fasteners for shock-mounting metal, plastic and glass panes and components. (262)

Furnace Temperature Indicator. Claud S. Gordon Co., 2 pp, illus. Describes device that quickly indicates any deviation from desired furnace temperature. (263)

Welding Studs. Nelson Stud Welding Div. of Gregory Industries, Inc. Wall Chart No. 1. Dimensions and applications of standard MG studs. A 12-page descriptive booklet is also available. (264)

Lock, Weld and Clinch Nuts. Grip Nut Co., 12 pp, illus. Specifications and applications for Gripco fasteners. (265)

Radiography. High Voltage Engineering Corp., 25 pp, illus. Importance of radiography as an inspection and quality control tool. Case studies are included. (269)

Heat Treating. Holcroft & Co., 12 pp, illus. Information on various types of Holcroft furnaces. (270)

Welding Electrodes. Lincoln Electric Co., 28 pp, illus., No. SB-1352. Guide for selecting electrodes for stainless steels, nonferrous metals, cast iron and manual hardsurfacing. (274)

Welding Aluminum Sheet. Linde Air Products Co., 1 p, No. 54-6R. Instructions for oxyacetylene welding of aluminum sheet. (275)

Rivets. Milford Rivet & Machine Co. A handy slide rule selector gives complete rivet specifications. (278)

Impact Testers for Metals. National Forge & Ordnance Co., Testing Machine Div., 4 pp, illus., No. 561. Describes features of impact testers for metals. Units have convenient controls, do not require skilled operators and conform to ASTM standards. (279)

Electric Furnaces. Pereny Equipment Co., 3 pp, illus., No. 4A. Advantages and illustrations of typical electric furnaces and kilns. (282)

Heat Treating Furnaces. Industrial Heating Dept., Westinghouse Electric Corp., 38 pp, illus., No. B-5459. Complete description of Westinghouse furnaces—large and small, gas and electric. (283)

One Point of View:

New awards program will recognize good materials selection

It has been only in recent years that the materials selection function has come to be recognized as an important and indispensable part of the planning and design of engineered parts and products. This recognition has largely developed as a result of placing the materials selection function on a sound engineering basis. Many companies, engineering departments and engineers have been and are contributing to strengthening this engineering approach through their efficient and practical use of new materials developments, as well as through their intelligent use of older, more conventional materials.

An awards program

It is to pay tribute to such accomplishments and to encourage more sound imaginative and progressive use of engineering materials that MATERIALS & METHODS has established an Awards Competition for the Best Use of Materials in Product Design (see p 115 for details).

Our obligation

As the only magazine devoted exclusively to the selection and use of engineering materials, we consider it not only a privilege, but also a special obligation to sponsor such an awards program. But the decision to start an awards program was not hastily made. We were fully aware of the overabundance of competitions, many of which are in, or border on, the design field. However, we were also aware of the fact that most of these awards are concerned with either the final product or the over-all design, or they are limited to one type of material or material form.

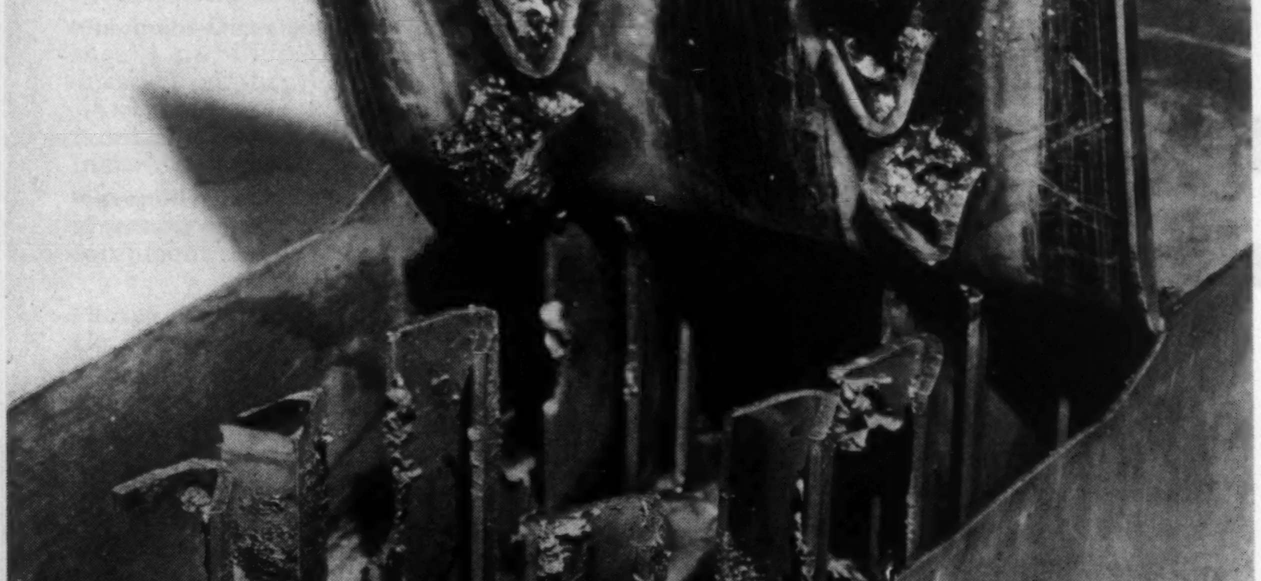
Furthermore, in our field trips we have observed that the critical importance of the materials selection function of the success of a product is still not as widely recognized as it should be. And we still witness too many misapplications of materials and too few examples of intelligent materials use.

All of these reasons convinced us of the need for an awards program that would recognize and reward those responsible for outstanding examples of intelligent materials use and, at the same time, would stimulate better selection and use of materials by industry.

Your entry will help

If you have designed or redesigned a part or product which you feel demonstrates the intelligent and efficient use of materials, we urge you to enter the competition. We believe that, with your support, this awards program will more firmly establish materials selection as an engineering and design function.

Protecting Molybdenum



Lewis Flight Propulsion Laboratory, NACA

Comparative performance *of Inconel and siliconized molybdenum in ramjet flame holder. After 5 min of operation, solid molybdenum prism remains intact amid remains of several Inconel gutters.*

Climax Molybdenum Co.

Erosion testing *coated molybdenum with hot blown alumina grit.*

■ The durability and performance of any protective coating for molybdenum will vary with duration and temperature of exposure and with gas composition and velocity. A coating for turbine blades and guide vanes must have all of the following properties to be successful:

1. Adequate oxidation resistance—Coatings must be free of pinholes and porosity. They should also possess a consistent minimum operating life of at least 50 hr and preferably 100 hr in the temperature range of 1800 to 2000 F.

2. Thermal shock resistance—Coatings should withstand rapid temperature changes. The difference in coefficients of thermal expansion between the base metal and the coating is particularly important since molybdenum has a very low coefficient—about 3.1 x 10^{-6} per °F. This compares with 6.7 x 10^{-6} per °F for iron and 7.2 x 10^{-6} per °F for nickel.

3. Impact and erosion resistance—Coatings must be capable of absorbing the impact of small, high velocity particles without cracking, or else should have some capacity for self-regeneration. They must also be able to withstand the erosive activity of high velocity combustion gases and small particles of sand, metals, oxides, etc.

4. Ductility and fatigue resistance—Coatings for molybdenum should be capable of withstanding a minimum amount of creep strain (1 to 2%) without fracturing. They should be applicable below the recrystallization temperature of the base molybdenum. The coating should not interact with the base alloy in such a way as to impart brittleness. The application technique must be suitable for coating complex shapes, and surface finish must be suffi-

at High Temperatures

To date it has been impossible to utilize the high temperature strength of molybdenum because of the metal's poor oxidation resistance. However, new coating developments show that:

1. *Electrodeposited chromium and nickel layers can protect molybdenum up to 2000 F.*
2. *Sprayed coatings may be applicable from 2000 to 2400 F.*
3. *Ceramic and molybdenum disilicide coatings hold promise for still higher temperatures.*

by Julius J. Harwood, *Head, Metallurgy Branch, Office of Naval Research*

ciently smooth for aerodynamic applications.

Electrodeposited coatings

With the possible exception of sprayed metal coatings, electrodeposited coatings seem most promising. Experiments have been conducted with a wide variety of metals—especially nickel, chromium and chrominum-nickel.

Nickel plate—Although it provides a fair degree of protection, nickel plate has not proved satisfactory because of 1) poor adherence to the substrate 2) poor resistance to thermal cycling and buckling (because nickel's coefficient of thermal expansion is higher than that of molybdenum), 3) difficulty in obtaining dense coatings, 4) rapid diffusion of molybdenum through nickel at 1800-2000 F, 5) spalling characteristics of nickel oxide and nickel molybdate, 6) the tendency for a recrystallized layer to form in molybdenum at the interface, and 7) formation of intermetallic compounds of nickel and molybdenum at the interface which lead to cracking upon deformation and impacting.

Nevertheless, nickel has good resistance to attack by molybdenum trioxide and is capable of bridging cracks or gaps in the underlying metal. Three mils of dense and adherent nickel can provide up to 500 hr of life at 1650 F. This protection drops off rapidly at 1800-2000 F, however, and at 2200 F its protective value is extremely limited.

Chromium plate—To date, it does not seem likely that a chromium electroplate will afford the consistent and reliable protection required for gas turbine operation. Molybdenum parts plated with 3 to 4 mils of chromium have lasted over 500 hr at 1800 F plus an additional 200 hr at 2000 F. In any one batch of identically plated parts, however, life may vary from 5 to 500 hr.

To provide effective protection, the chromium plate must be free from network cracking. Molybdenum has a lower diffusion rate in chromium than in nickel, and the solid solution chromium-molybdenum alloy that is formed at the interface may be the reason for the protection given by chromium deposits. Like nickel, chromium plates do not stand up particularly well in thermal cycling tests and are likely to fail bady in impact tests.

Chromium-nickel plate—Of all the coating systems tested, electroplated layers of chromium and nickel appear to offer the most promise for turbine blade applications up to 2000 F. For less severe applications, however, many of the other coatings systems and techniques described undoubtedly will be completely satisfactory for protecting molybdenum.

Test results clearly demonstrate the importance of good surface preparation, correct plating procedures, high quality of the molybdenum sheet, and proper methods of attaching leads in obtaining reproducible performance of electrodeposited coatings. The best method of producing a clean substrate surface is

1. If necessary, removal of oxide films by anodic pickling in 70% sulfuric acid.
2. Degreasing and pumice polishing.
3. Etching in a solution of potassium ferrocyanide (300 gm/1) and potassium hydroxide (100 gm/1). Immersion for ½ to 1 min at 185 F with constant agitation produces a good etch.

One of the best chromium underplates has been obtained in a "low contraction" bath:

Chromic acid	500 gm/l
Sulfuric acid	5 gm/l
Current density	120 amp/sq dm
Temperature	170 F

Under these conditions chromium is deposited at a rate of 0.0005 in. per hr with excellent adhesion and good bend ductility. After degreasing and rinsing, specimens are immersed in 50% hydrochloric acid until vigorous evolution of hydrogen occurs. Without rinsing, parts are given a Wood's nickel strike, then rinsed and plated in a chloride bath:

Nickel chloride	240 gm/l
Boric acid	30 gm/l
pH	3 to 4
Current density	4 amp/sq dm
Temperature	Room

The oxidation resistance of various thicknesses of nickel deposited on a standard 1-mil layer of chromium (the optimum thick-

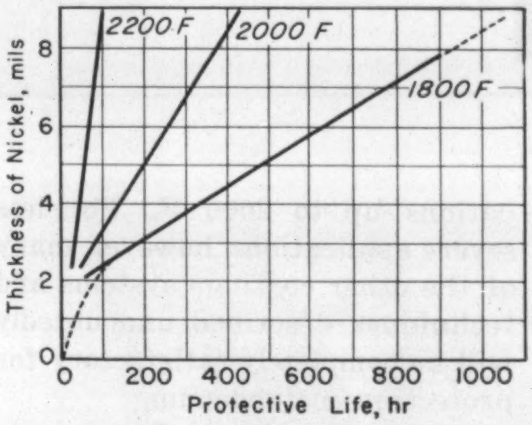


***Fig 1** — Effectiveness of varying thicknesses of nickel over a 1-mil chromium layer in protecting molybdenum against oxidation.* **(Brenner)**

ness recommended) is shown in Fig 1. For a given thickness, the service life decreases with increasing temperature. A minimum of 2 mils of nickel is necessary to provide any significant protection. Above this minimum value the protective life at any given temperature varies linearly with the thickness of nickel. There are practical limits to the application of this rule, however, and it is obvious that at 2200 F even 9 mils of nickel would not provide practical oxidation resistance for molybdenum turbine blades. In contrast, thousands of hours of protection may be achieved at 1700 F.

Results of recent tests indicate that a nickel plate from a Watts bath can provide better and more reproducible oxidation resistance than plates from a nickel chloride bath. Molybdenum parts plated with 1 mil of chromium and 7 mils of nickel from a Watts bath have exhibited a minimum life of 260 hr and a maximum life of 760 hr at 2000 F. In comparison,

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Why Molybdenum Needs a Protective Coating

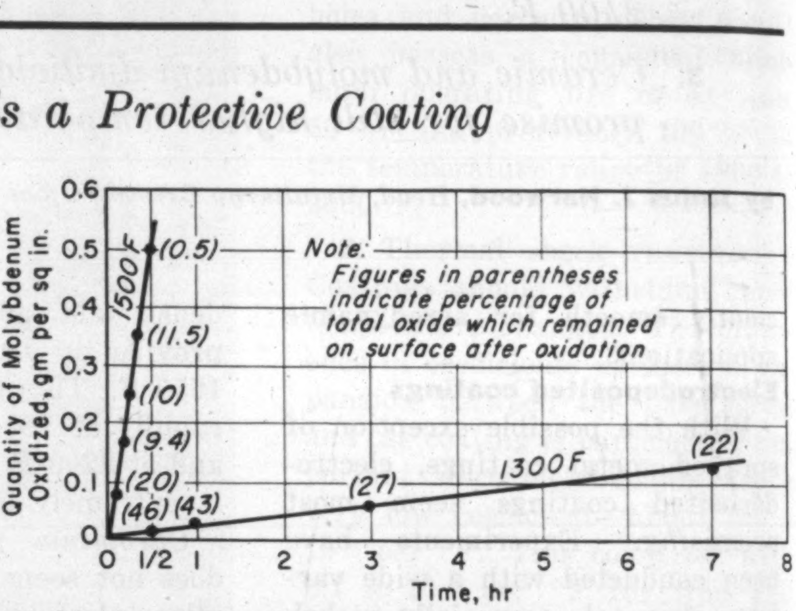
With the recent development of molybdenum base alloys that possess outstanding strength at high temperatures, a good deal of attention has been focused upon their potential use as structural materials for high temperature military applications. Although numerous applications are being considered, current development centers largely around critical gas turbine parts such as turbine blades and guide vanes. It is anticipated that by using molybdenum gas turbines can be developed with operating temperatures in the range of 1800 to 2000 F, or even higher, with a substantial increase in engine performance and efficiency.

Oxidation behavior

The major obstacle limiting the wider use of molybdenum alloys in gas turbines and other high temperature applications is their complete lack of oxidation resistance at temperatures over 1000 F. Despite its 4750 F melting point, molybdenum oxidizes rapidly—to the point of complete disintegration—at elevated temperatures. This condition is caused by the volatility of molybdenum trioxide (the end product of the oxidation reaction) which prevents the formation of a protective oxide.

In general, below 932 F oxidation follows a parabolic curve, indicating some degree of self protection. Oxidation proceeds by a two-step process with what is believed to be molybdenum dioxide (MoO_2) as the intermediate oxide layer and molybdenum trioxide (MoO_3) as the outer layer. Above 932 F, the molybdenum trioxide begins to volatilize and at about 1415 F its evaporation rate is equal to its rate of formation. The appearance of molten MoO_3 at 1500 F produces extremely rapid oxidation since the liquid oxide can run off the surface and increased oxygen diffusion can occur through the liquid oxide phase (see accompanying graph).

In slowly flowing air at 1800 F, the surface of molybdenum recedes at the rate of 0.02 to 0.05 in. per hr. These rates may increase as much as two-fold as air velocity is increased. In comparison, the maximum permissible oxidation rate at 1800 F for a satisfactory iron-chromium-nickel alloy is about 0.000013 in. per hr. Oxidation rates ranging between 0.58 and 0.92 gm per sq cm per hr have been observed for molybdenum at 1750 F in slowly flowing air.



***Oxidation rate** of unprotected molybdenum sheet in still air at 1300 and 1500 F.* **(Gleiser)**

From the above it is evident that unprotected molybdenum is completely useless as a structural material above 1000 F in oxidizing atmospheres except for very short periods. Some form of protection against oxidation must be provided if molybdenum alloys are to achieve their full potential as high temperature structural materials.

Combating oxidation

Ordinarily, the most desirable approach to the problem of rapid oxidation would lie in the development of molybdenum alloys capable of forming a protective surface oxide or molybdate film. This would be in keeping with the general methods of achieving oxidation resistance in other metal systems. A large number of binary and ternary alloys have been investigated, the most promising of which include alloys of chromium and titanium, chromium and nickel, silicon, nickel, and cobalt. Although these alloys have an oxidation rate 100 times lower than unalloyed molybdenum, their oxidation resistance is still far from satisfactory for engineering applications. Also, the large amounts of alloying elements required make the alloys unworkable and impair high temperature strength properties.

To date, no molybdenum alloy has been developed with the combination of good oxidation resistance at 1800 F and good high temperature strength properties. That is why major attention in recent years has been given to the development of protective coatings for molybdenum.

parts plated in the chloride bath exhibited a minimum life of 70 hr and a maximum life of 360 hr at the same temperature. At 1800 F the minimum life of parts plated in a Watts bath was 740 hr, with most specimens lasting over 1200 hr. The equivalent minimum time to failure for parts plated in a chloride bath was only 160 hr.

Thus, for the first time, techniques are available for electrodepositing of chromium and nickel on molybdenum with reproducible and satisfactory oxidation resistance. The present chromium-nickel coatings by no means represent the optimum which may be achieved. Highly promising results have been obtained with additions of other elements to increase oxidation resistance, and further study is warranted.

Claddings

Cladding can be used to provide oxidation resistance for molybdeum sheet or other simple shapes. Most oxidation resistant metals and alloys can be clad to molybdenum. Of the various metals evaluated, nickel, nickel-chromium alloys, Inconel and other high nickel alloys show greatest promise. The oxidation resistance of clad molybdenum is dependent upon the thickness and scaling resistance of the cladding materials. In choosing the proper thickness, an engineering compromise must be made between optimum oxidation resistance and minimum acceptable loss of strength. In all cases, design strength of the composite should be based upon the strength of the molybdenum core alone.

Early work on cladding indicated that 15 mils of nickel on each side would protect molybdenum from oxidation for about 1800 hr at 1800 F and up to 250 hr at 2200 F. Recent development, however, has been concentrated on thinner claddings, ranging from 3 to 7 mils.

Claddings of Inconel and an 80-20 nickel-chromium alloy have given good protection for 100 hr at 2000 F. On samples where such claddings have been completely penetrated, superior protection has been provided by unalloyed and high nickel alloys (92% nickel). Although nickel has a high scaling rate, it will continue to protect molybdenum as long as any of it is on the surface. (The ability of nickel-rich claddings to provide protection in the presence of local defects is believed to be due to the formation of nickel molybdate.) However, cooling nickel-rich coatings to room temperature produces spalling and probable loss of any protective properties.

Sprayed metal coatings

Within certain limitations, several sprayed metal coatings have shown considerable promise in protecting molybdenum at high temperatures. All of the alloys shown in Tables 1 and 2 have proved capable of protecting molybdenum against oxidation in air for at least 500 hr at 1800 F. Of these coatings, the aluminum-chromium-silicon alloys and the nickel-boron alloys have proved most effective. Addition of aluminum to the silicon alloys raises their melting point so that they can be useful up to 2400 F. Because of their lower melting point, use of nickel-boron coatings is limited to about 2000 F.

In thermal shock and cycling tests (see Table 2) the aluminum-chromium-silicon (Al-Cr-Si) alloys have proved superior to all other sprayed coatings. In ballistic impact tests, nickel-boron-silicon (Ni-B-Si) and nickel-boron-silicon-chromium (Ni-B-Si-Cr) alloys are able to withstand the impact of steel shot at 330 ft per sec without exhibiting any deterioration in subsequent oxidation resistance at 1800 F. Under the same conditions, aluminum-chro-

TABLE 1—COMPOSITIONS (%) OF SPRAYED METAL COATINGS FOR MOLYBDENUM

	Si	Cr	A1	Ni	Mo	B	Fe	Other
Chromium-Silicon Alloy	40.55	55.96	0.44	—	—	—	1.40	—
Chromium-Molybdenum-Silicon Alloy	32.97	31.30	—	—	31.29	—	0.71	-
Molybdenum-Nickel-Silicon Alloy	32.17	—	1.53	30.57	37.0	—	0.22	—
Iron-Silicon Alloy	50.78	—	—	—	—	—	bal	—
Nickel-Silicon Alloy	30	—	—	60	—	—	7	3 Ca
Nickel-Chromium-Boron Alloy (Colmonoy No. 5)	4.01	12.07	—	79.16	—	2.36	4.13	0.46 C
Nickel-Chromium-Boron Alloy (Colmonoy No. 6)	4.33	15.29	—	72.19	—	2.77	4.41	1.02 C
Nickel-Silicon-Boron Alloy (Coast Metals 50)	3.5	—	—	93.25	—	2.25	—	1.00 C

TABLE 2—EFFECTIVENESS OF SPRAYED METAL COATINGS ON MOLYBDENUM

Test	Effective Life of Coating		
	A1-Cr-Si	Ni-Cr-B	Ni-Si-B
Oxidation at 1800 F[a] followed by:	500+ hr	500+ hr	500+ hr
Oxidation at 2000 F	100+ hr	100+ hr	100+ hr
Oxidation at 1800 F (cylinders with 5-mil coating) followed by:	500+ hr	500+ hr	—
Oxidation at 2000 F	283 to 500+ hr	83 to 500+ hr	—
Thermal shock: cycles to failure	504 to 627	185 to 285	108 to 150
Ballistic impact (using shot at 330 fps[b]): life of coating at 1800 F after impacting	0	500+ hr	500+ hr
Erosion test (using aluminum oxide grit): life of coating at 1800 F	25 to 30 min	57 to 60 min	40 to 50 min

[a] 75 consecutive specimens with A1-Cr-Si coating sustained 500 hr exposure at 1800 F without failure.

[b] With a shot velocity of 135 ft per sec, specimen life after impacting was 160 to 170 hr.

mium-silicon (Al-Cr-Si) coatings chip badly and have no useful oxidation resistance afterwards.

Cracks occur in sprayed coatings during oxidation tests, but the fact that the molybdenum does not oxidize indicates that the cracks are apparently sealed off. Nozzle guide vanes, flame holders, gas generators, and stirring rods for molten glass have been metallized with the most promising of the above coatings and are under evaluation. Results to date have been favorable.

Diffusion coatings

Of all the diffusion coatings formed by the pack cementation process, silicon, titanium chromium-aluminum, and particularly zirconium coatings have shown the most promising protection against oxidation. Thermal cycling, however, reduces the protection given by these coatings by a factor of 20.

Hot dipping of various coatings such as aluminum and its alloys and nickel-chromium alloys (containing boron and silicon) has also been investigated as a means of imparting oxidation resistance to molybdenum. In general, nickel-chromium alloys have given the best oxidation protection. Except for aluminum, coating quality has often been inconsistent due to dross occlusion, but this problem appears capable of being resolved.

Chromized coatings have exhibited good oxidation behavior at 1500 F and are now under evaluation for higher temperature service. Since long time periods and high temperatures are needed to form a thick chromium-molybdenum case, it is doubtful that chromizing can be used alone. Nevertheless, chromizing does offer a real potential for forming an oxidation resistant surface alloy which can serve as the base for other protective coatings, such as chromium-nickel, chromium-nickel-aluminum, etc.

Molybdenum disilicide coatings

Few coatings have demonstrated the oxidation protection of a dense, pore-free disilicide coating ($MoSi_2$) on molybdenum. Some of the methods by which a disilicide layer can be obtained are vapor deposition or siliconizing, pack coating in powder silicon in a halogen atmosphere (cementation), painting or spraying with a slurry of silicon, and hot dipping in a molten alloy of silicon. Experience indicates that coatings of 3 to 4 mils are best, since thicker coatings tend to crack because of differences in thermal expansion. Some average values of expected life in stagnant air are as follows:

1500 F	6000 hr
2000 F	2000-2500 hr
2500 F	200-800 hr
3000 F	50-300 hr

Because of eutectic melting, upper temperature limit of the disilicides is about 3270 F. Stress-rupture tests at 1800 F indicate that creep rates greater than 0.0075% per hr and stress levels greater than 10,000 psi can produce premature failure. Thermal shock resistance of the coatings is reasonably good, and at high temperatures coated parts can be bent without cracking. Deformation at lower temperatures causes failure.

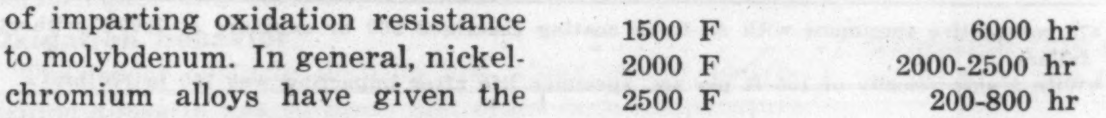
Despite its excellent oxidation resistance, disilicide-coated molybdenum suffers from some serious drawbacks including: 1) poor resistance to impact, 2) inadequate ductility, 3) cracking caused by low creep stresses, 4) poor fatigue resistance, 5) the need for application above the recrystallization temperature of molybdenum, and 6) unreliability and premature failure.

From the above it is evident that for applications in which oxidation resistance is the primary requirement, molybdenum disilicide coatings prove quite satisfactory. However, when ductility or impact resistance is an important co-factor in design, their use will be extremely limited.

Ceramic coatings

Because of their relatively high melting point, stability and resistance to hot gas erosion, ceramic compositions were among the first materials to be evaluated for protecting molybdenum. Numerous coatings have been tested, including alumina, magnesia, silica, rutile, zirconia, beryllia, borax, glasses, sillimanite, etc., and many different combinations of these inorganic compounds. The most common type of coating evaluated has consisted of a combination of a refractory oxide and a glass phase, designed to produce a minimum of differential expansion between it and the base molybdenum.

Despite some successful laboratory tests, ceramic coatings exhibit the following disadvantages: 1) poor impact resistance, 2) inadequate ductility, 3) questionable resistance to thermal shock, 4) difficulty in obtaining good adherence and coverage at edges and corners, 5) need for firing temperatures above the recrystallization temperature of molybdenum, and 6) reactivity of most oxides with molybdenum trioxide which tends to destroy the usefulness of the coating.



Climax Molybdenum Co.

***Ballistic impact** testing of coated molybdenum. Heated parts are impacted with steel shot and then subjected to static oxidation test in air at 1800 F.*

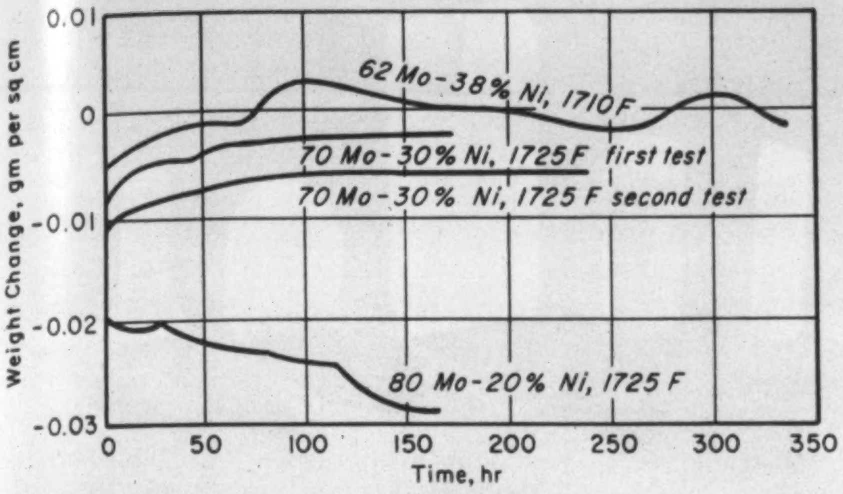


Fig 2—*Relative oxidation resistance of three molybdenum-nickel alloys.* (Gleiser)

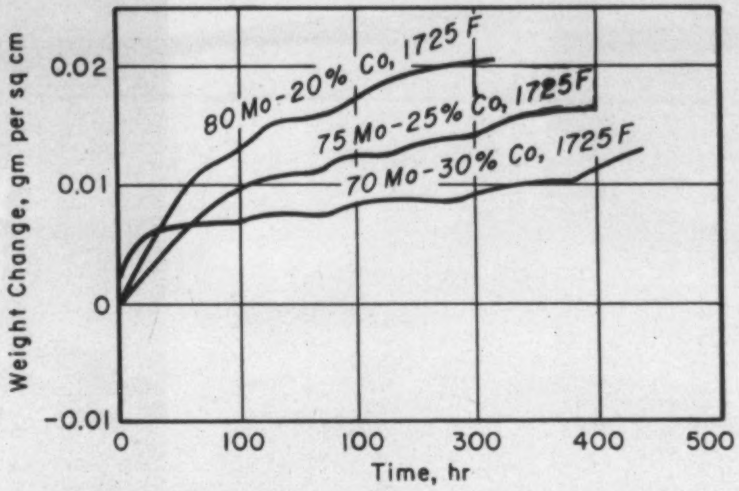


Fig 3—*Relative oxidation resistance of three molybdenum-cobalt alloys.* (Gleiser)

Despite these disadvantages, ceramic coatings should be quite useful for short time applications or where severe thermal shock, high stresses or impact conditions are not involved. For turbine blade applications it is doubtful that ceramic coatings can be used as the main source of protection. They may well have a future in multilayer systems in which they will provide an impervious, erosion resistant, outer layer on an oxidation resistant, ductile base coat.

Surface barrier layers

An evaluation of the oxidation resistant molybdenum alloys mentioned earlier indicates that physical barriers consisting of molybdenum combined in the form of an oxide or molybdate might be effective in reducing oxygen diffusion. The materials which seem to possess the desirable properties of water insolubility, high melting point and temperature stability include molybdates of barium, lanthanum, lead, cobalt, nickel and magnesium.

The relative oxidation resistance of three molybdenum-nickel alloys is shown in Fig 2. All alloys exhibit a green oxidation product on the surface identifiable as nickel molybdate. Indications are that binary molybdenum alloys possess good oxidation resistance up to about 1800 F. As shown in Fig 3, similar results were obtained with molybdenum-cobalt alloys, although the protection given by the molybdenum-cobalt layer is somewhat inferior to that given by nickel molybdate. Spalling of both the nickel and the cobalt alloys occurs when oxidized samples are cooled to room temperature.

Although manganese dioxide is effective in stabilizing nickel and cobalt molybdates, the high amount of manganese required to prevent spalling reduces the protective value of the coating. Because of their unsatisfactory high temperature properties, ternary alloys of molybdenum may only be useful as coatings for other high temperature molybdenum-base alloys. For short time applications up to 2000 F, molybdenum-silicon-nickel and molybdenum-cobalt-silicon coatings may be highly effective. The ductility of these coatings is marginal. However, these coatings have the capacity for self-healing and regeneration when damaged.

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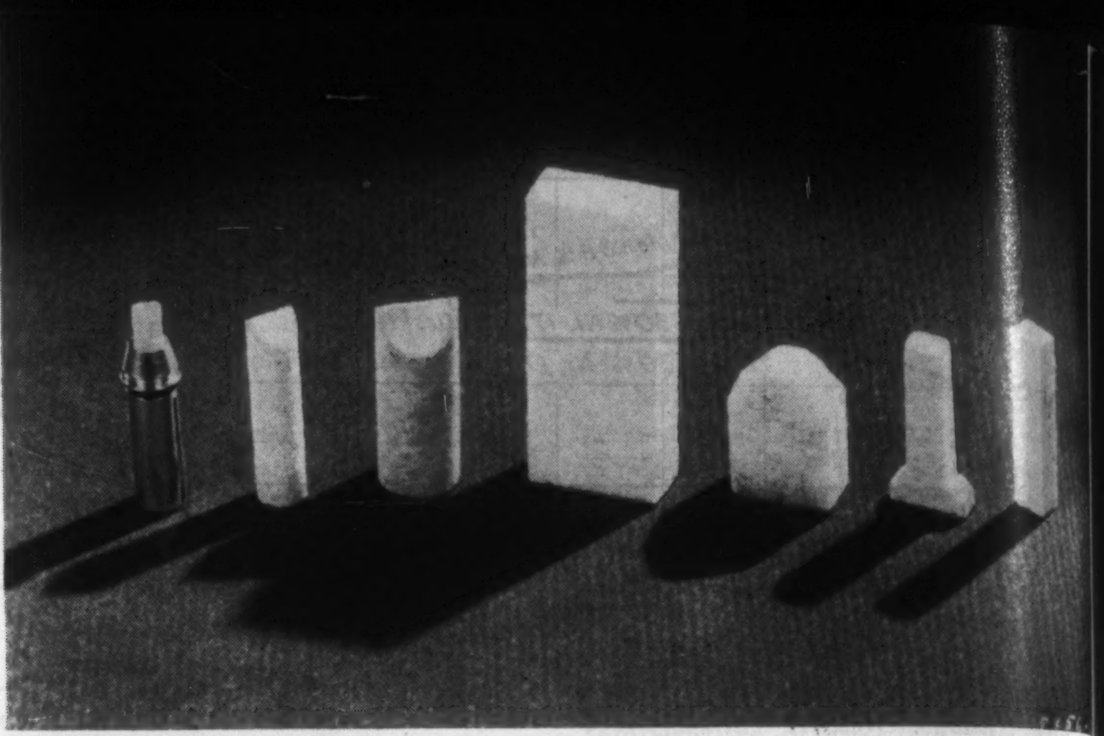
The views and opinions expressed are those of the author and do not necessarily reflect the official attitude of the Office of Naval Research or the Navy Dept.



Better wicking—*Moisture absorption characteristics of felts can be altered by special treatments. Ink stamp pad (center) is flanked by several types of treated felts for marking pens.*

Here are some reasons for using . . .

Treated Felts

Although wool felt alone is a versatile engineering material, many of its properties can be improved by various treatments such as impregnation and lamination. This article tells what treatments are available and where they can be used to advantage.

by Malcolm W. Riley, *Associate Editor, Materials & Methods*

■ The value of felt as an engineering material can be enhanced by special treatments applied by the materials supplier. Since felt is available as a stock material in densities ranging from 16 to 21 lb per cu ft in rolls, and 16 to 43 lb per cu ft in sheets, a wide range of properties is available to the engineer in standard types of felt. Only where this property range is insufficient for optimum design, or where felt must be protected from environmental hazards, should treated felt be specified.

Felt treatments consist of chemical modification, impregnation, lamination, surface coating and combinations of these treatments. They are used to: 1) change the basic physical properties of the felt, providing the engineer with a wider range of properties; 2) protect the felt; or 3) improve forming characteristics and simplify fabrication. In many cases combinations of treatments are used to serve more than one of these purposes.

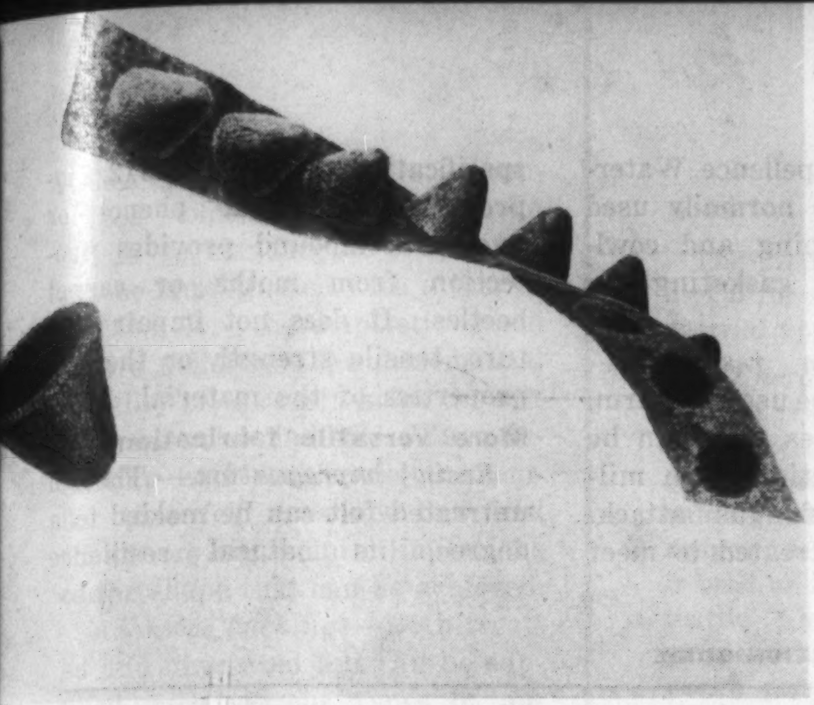
Altered properties

Stiffness or strength—Felt can be impregnated with starch, rubber lattices or synthetic resins to increase its stiffness or strength. In general, dextrin sizings are used where the felt is to operate in dry environments. Various types of such sizings can be used to provide a wide range of stiffness. This increased stiffness provides support for thin walls and better handling characteristics for cut parts.

Where improved flexibility and increased strength in the presence of moisture or lubricants are required, felt can be impregnated with natural or synthetic rubber or resin lattices. Impregnant content can vary from 5 to 100% of solids. Selection of the proper rubber or resin and the proper proportion of impregnant to felt depends on service conditions, e.g., the chemical resistance required, as well as on the amount of strengthening or resilience desired. Rubber-impregnated felts are used for such applications as flexible stiffening, sealing and gasketing.

The maximum in strength and stiffness is obtained by impregnating felt layers with natural or synthetic rubber or resin and forming a high pressure laminate. With this type of treatment the product should be defined as a felt fiber-reinforced rubber or plastic. Tensile strengths are on the order of over 2000 psi, resistance to hydraulic pressure is about 2500 psi maximum, and Shore A durometer hardness is about 90. This type of material is useful for applications such as marine pump packings and gaskets, embossing bed blankets, friction brakes or clutch linings, and seals or molded washers.

Wetting speed—Though felt by nature is a highly absorbent material, the speed of wetting or



Better fabrication—*Molded felt shapes hold their form when impregnated with synthetic resins.*

All photos courtesy Felt Assn.

Better insulation—*Insulation felts, chromate treated, are used between dissimilar metals in railroad passenger car structures.*

wicking can be altered by treatment. Impregnation with wetting agents such as alka aryl sulfonates or sulfonated alkyl esters reduces the surface tension of liquids with which the felt is used, allowing the felt to wet out more easily and wick more rapidly. By selecting the proper basic felt and applying the proper wetting agents, speed of wetting and thus the wicking-rate can be closely controlled. The treatment has no effect on other properties of the felt.

These types of treated felt are used for ink stamp pads, tape moisteners and ink rollers, and to feed process liquids in automatic machinery.

Coefficient of friction — Untreated felt has a relatively low coefficient of friction, ranging from 0.18 against oiled metal to 0.37 against wood. Frictional characteristics can be altered to suit almost any desired application by impregnation or coating.

Dry frictional coefficients can be reduced to extremely low values by impregnation with graphite, waxes or paraffin. Higher coefficients of friction can be obtained by impregnating with dispersions of colloidal silica. Where extremely high frictional properties are desirable, a coating or laminate of natural or synthetic rubber can be applied. Frictional characteristics of virtually any material that can be applied in coating form can be achieved by coating the felt.

Permeability — Permeability of felts used for filtration can be closely controlled by altering fiber type and density. Where felt is to be used for packings, seals, washers or gaskets to protect operating parts from dirt, foreign matter or water, it can be impregnated with rubber, paraffin, petrolatum or graphite. Asphalt impregnations are usually used for weather seals.

For seals or packing washers used to retain low viscosity oils, greases or hydraulic fluids, felt can be laminated with impervious membranes of Hycar, neoprene or Buna-S, depending on specific service environments. Such seals can be adapted to a variety of designs since a membrane may be laminated to one side of the felt, or several membranes may be interspersed between layers of felt. Also, different types of felt can be used on either side of a membrane so that one side may serve as a reservoir and the other as a protective shield. Strength of the bond between such membranes and felt can be greater than the strength of the felt itself.

Corrosion characteristics—Felt can be adjusted to a specified pH value so that it will not corrode metals with which it is in contact. Felts can also be treated with chromates which provide corrosion protection to metals. Chromate treated felts can be used as protective seals between dissimilar metals, preventing galvanic corrosion. Many such treated felts are now being marketed with and without adhesive backings.

Electrical qualities—Felts can be treated either to induce or to dissipate static electrical charges. By impregnation with a solvent solution of resin, the felt can be made to induce static charges, thus producing a filter material that will attract submicroscopic particles of dust in the air. Where dissipation of static charges is desirable, felt can be impregnated with a nonionic compound, lowering the resistivity of the fibers.

Proofing or protection

Flame resistance — Untreated wool or wool and cotton felts are slow burning materials which exhibit two types of combustion. Combustion by flaming occurs when flammable gases of thermal decomposition unite with oxygen to produce flame. Flameless combustion occurs when oxygen vigorously combines with the fiber to produce glowing. Flame proofing treatments currently applied to felts make them self-extinguishing, and reduce the period of afterglow to seconds. Such treatments have no effect on the other properties of felt.

Water repellence—By impregnation with a water resistant, flexible, nonleaching, noncorrosive material, such as a silicone resin, felt can be made to shed water, though it is not made impervious. Felt may also be impregnated with waxes, paraffin, petrolatum or combinations of these materials to provide water repellence. Water-repellent felts are normally used for weather-stripping and cowl-stripping, and as gasketing for plumbing fixtures.

Mildew, vermin resistance—When felts are to be used in warm, moist or wet places they can be treated for protection from mildew, mold and fungus attack. Materials can be treated to meet specifications of MIL-M-2312. Impregnation with a phenol or fluorine compound provides protection from moths or carpet beetles. It does not impair texture, tensile strength or thermal properties of the material.

More versatile fabrication

Resin impregnation—Though untreated felt can be molded to a degree, its natural resilience

ADHESIVE SELECTION GUIDE

Adhesive / Application	Natural & Reclaim Rubber Cements	Natural Rubber Latex	Neoprene	GR-S	Hycar	Synthetic Rubber and Resin	Casein	Casein and Rubber	Glue	Gutta Percha	Sheet Vinyl	Shellac	Solvent Gum	Solvent Cut Resin
TO JOIN FELT TO:														
Acrylics	—	—	—	—	—	X	0	—	—	—	—	—	0	X
Aluminum	0	—	0	0	0	X	—	—	—	—	—	—	0	—
Brass	—	—	—	X	—	0	—	—	—	—	—	—	0	—
Bronze	—	—	—	X	—	0	—	—	—	—	—	—	0	—
Buna S	—	—	—	X	—	0	—	—	—	—	0	—	—	—
Cast Iron	0	—	0	0	0	X	—	—	—	—	—	—	0	—
Celluloid	—	—	—	—	—	—	—	—	—	—	—	—	—	X
Cellulose Acetate	—	—	—	—	—	0	—		—	—	—	—	0	X
Ceramics	0	—	0	0	0	0	—	0	0	—	—	0	X	0
Concrete	0	—	0	0	0	0	—	0	—	—	—	—	X	—
Copper	—	—	—	X	—	0	—	—	—	—	—	—	0	—
Cork	X	0	0	0	0	0	0	0	0	—	—	—	0	0
Enamel	—	—	—	—	—	X	—	—	0	—	—	0	0	0
Ethyl Cellulose	—	—	—	—	—	0	—	—	—	—	—	—	0	X
Fabrics	—	X	0	0	0	0	—	0	—	X	X	—	—	—
Felt	—	X	0	0	0	0	—	0	—	0	X	—	—	—
Formica	—	—	—	—	—	0	—	—	0	—	—	0	0	X
Glass	0	—	0	0	—	X	—	—	0	—	0	0	0	0
Hycar	—	—	—	—	0	X	—	—	—	—	0	—	—	0
Iron	0	—	0	0	0	X	—	—	—	—	—	—	0	—
Leather	X	0	0	0	0	0	0	0	0	—	—	—	0	—
Lignin	0	—	0	0	0	0	X	—	0	—	—	0	0	0
Magnesium	0	—	0	0	0	X	—	—	—	—	—	—	0	0
Mica	0	—	0	0	0	0	0	—	X	—	—	0	0	0
Micarta	—	—	—	—	—	—	—	—	—	—	—	—	0	X
Neoprene	—	—	X	—	—	0	—	—	—	—	0	—	—	—
Nickel	0	—	0	0	0	X	—	—	—	—	—	—	0	—
Nylon	0	—	0	0	0	X	—	—	—	—	—	—	0	0
Paint	0	—	0	0	0	X	0	0	0	—	—	0	0	0
Paper	X	0	0	0	0	0	—	0	0	0	0	—	—	—
Phenolics	—	—	—	—	—	X	0	—	0	—	—	0	0	X
Rubber, Natural	X	—	—	—	—	0	—	—	—	—	0	—	—	—
Steel	0	—	0	0	0	X	—	—	—	—	—	—	0	—
Vinyls	—	—	—	—	—	0	—	—	—	—	—	—	—	X
Wood	0	—	0	0	0	—	0	—	0	—	—	0	0	—
FOR RESISTANCE TO:														
Acids	0	X	—	—	—	—	—	—	—	—	0	—	—	—
Gasoline	—	—	—	—	0	X	0	—	0	—	0	0	—	0
Greases	—	—	X	—	X	0	0	—	0	—	—	0	—	0
Oils	—	—	X	—	X	0	0	—	0	—	0	0	0	0
Solvents	—	—	—	—	0	X	—	—	—	—	—	—	—	0
Tricresyl Phosphate	X	X	—	—	—	—	—	—	—	—	—	—	—	—
Water	X	—	0	—	—	0	—	—	—	—	0	—	0	—

X—Preferred for general application. O—Usable for specific application.

makes retention of the unsupported molded shape difficult. To obtain permanence of shape, felt can be impregnated with a thermosetting or thermoplastic resin before molding. The dimensional stability of the resin holds the felt in shape after molding. When designing with molded felt remember that felt does not flow and thus there are definite limitations to the shape that can be achieved.

Adhesive backings—Both treated and untreated felt can be supplied with various types of adhesive films applied to one or more of its surfaces. The nature of felt's fibrous structure ensures a good bond between the adhesive and the felt.

Adhesives most commonly used with felt are solvent- or water-base compounds of natural or reclaim rubber, neoprene or Hycar. Solvent-base adhesives can be supplied as pressure sensitive, heat sensitive, direct combination, dry tack and solvent wet back types. Water-base adhesives are limited largely to direct combination and dry tack types. For special applications, natural gums, glues, caseins, vinyls and gutta percha sheet laminas can be used.

Selection of the proper adhesive is generally governed by 1) nature and surface character of the material to which the felt is to be bonded; 2) strength and flexibility requirements of the bond; 3) service environment, i.e., operating temperature and resistance needed to moisture, solvents, oils and chemicals; 4) method of application preferred; 5) curing cycle desirable; and 6) production quantities and cost considerations. An accompanying table lists preferred and usable types of adhesives for joining felt to various materials and for resistance to specific types of environments.

Typical applications for each of the types of adhesives are as follows:

Pressure sensitive — weather stripping and mechanical spacer strips.

Heat sensitive — fabric-backed felts and laminated felts.

Direct combination — vibration mountings and lamp and instrument bases.

Dry tack—shoe and drawer linings.

Solvent wet back—filter bag seaming and joining to rubber.

Why and Where Felt Is Used

The properties of felt make it useful for six major types of industrial applications. They are:

1. *Energy absorption* — The natural resilience of felt makes it an excellent material for energy absorption. Absorption values vary widely over the range of densities available. Felt is used under such equipment as textile machinery, printing presses, drop hammers and punch presses to absorb vibration and impact. It is also used as protective packing for fragile products such as china, glass or electronic equipment. Special types of felt are used as protective channels in car windows and as squeak strips between car chassis and body.

2. *Friction* — Frictional characteristics of denser felts are useful for polishing and wiping metal, glass and other materials, and in some clutching and braking applications. Coarseness of the fiber and density of the felt are chosen to suit individual polishing applications. Where more abrasion is required than can be supplied by felt alone, felt wheels are coated with abrasives.

3. *Sealing*—Felt is used for packings, gaskets and other types of seals because of its resilience, which allows constant sealing pressure; its low coefficient of friction, which minimizes wear and heat build-up; and its oil and moisture absorption characteristics. The material can be used to retain oils and greases and/or exclude dust, fumes and moisture.

4. *Wicking*—The capillarity of felt coupled with its moisture-holding structure make it an ideal material for lubrication feeds and reservoirs. Efficient wicking action can be engineered by designing wicks with the proper absorption capacity, wick-rise rate and wicking distance. For automatic lubrication of bearings, felt is used in bottom wick oilers, siphon wick oilers, absorbent or pad feed oilers and top feed oilers. Besides lubrication applications, felt wicks are used to feed water, ink and other process fluids in equipment such as automatic printing equipment, numbering machines and postage meters.

5. *Filtration*—The controlled permeability and particle retention efficiency of felt suit it for filtration of air, gases and liquids. Also, wool is nonreactive to many chemical agents and felt can be made chemically neutral. Felt filters are used for such applications as industrial air filtration and air conditioning, and for processing industrial chemicals, paints, film dope and nutrient broths.

6. *Insulation* — The fibrous, porous, matted structure of felt makes it a natural thermal and acoustical insulator. For thermal insulation, untreated felt can be used continuously at temperatures up to about 200 F, and intermittently at higher temperatures.

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Acknowledgment

The author would like to thank T. J. Gillick and R. R. Stevens of the Standards and Marketing Committee of the Felt Assn. for reviewing the manuscript, and the personnel of member companies of the Felt Assn. for assistance in gathering information.

Steel Grade	Brindell Hardness	Operation	Speed	Feed, in.	Depth of Cut, in.	Tool Wear, in.	Results of Using Leaded Steel
4137	290-330	Turning	2¾ rpm	1/32	⅛	—	
41L37	290-300		6 rpm	1/32	3/16	—	69% less time
4137	290-330	Tooth cutting	35 strokes	0.028	—	¼	1600% longer tool life, 94% less tool wear
41L37	290-330		35 strokes	0.028	—	1/64	
4140	285-302	Turning	17 rpm	0.0208	—	—	
41L40	285-302		25 rpm	0.0208	—	—	47% less time
4140	285-302	Tooth cutting	37.5 strokes	0.017	—	0.044	41% less time, 437% longer tool life, 77% less tool wear
41L40	285-302		46.5 strokes	0.024	—	0.010	
4150	255	Turning (face cuts)	275 sfm	0.016	—	—	
41L50	255		475 sfm	0.021	—	—	56% less time
4150	255	Turning (plunge cuts)	276 sfm	0.005	—	—	
41L50	255		475 sfm	0.010	—	—	71% less time
4150	255	Tooth cutting roughing	89 strokes	0.0237	0.62[a]	—	21% less time, 200% longer tool life, 50% less tool wear
41L50	255		111 strokes	0.0295[b]	0.62	0.014	
4150	255	Tooth cutting (finishing)	89 strokes	0.0237	0.030[b]	0.028	47% less time, 187% longer tool life, 46% less tool wear
41L50	255		111 strokes	0.0368[c]	[d]	0.015	
1070	240-260	Tooth cutting	32 rpm	0.048	0.69	0.20	
10L70	240-260		40 rpm	0.076	0.69	0.20	50% less time

[a] Roughing cut using cutter from finishing cut on 4150 material.

[b] Finishing cut using freshly ground cutter.

[c] Free of heavy burrs found on regular material.

[d] Roughing and finishing cuts.

This table shows how . . .

New Leaded Steels Reduce

New process makes leaded steels available in larger ingots and with improved fatigue properties.

by C. R. Funk, *Chief Metallurgist, Alco Products, Inc.*

■ Introduction of lead into steel by a new process developed by our company extends the advantages of leaded steels to larger ingot sizes than could be produced previously. The new steels, called Hi-Qua-Led, are now in commercial production in ingots up to 50,000 lb and in forged or rolled rings from 18 to 145 in. o.d.

The 1000 series carbon steel grades containing from 0.15 to 0.70% carbon and alloy grades 4130, 4140, 4150, 4340 and 4640 have been leaded by the Alco process (patent applied for). In each case, basic properties of the steel remain unchanged and the pattern of lead distribution is unaffected by the grade. Lead distribution is so complete that microscopic examination during early work failed to reveal the presence of lead although chemical analysis showed a substantial lead content. It is the extremely fine dispersion of lead that makes possible the use of these leaded steels in such critical applications as gears.

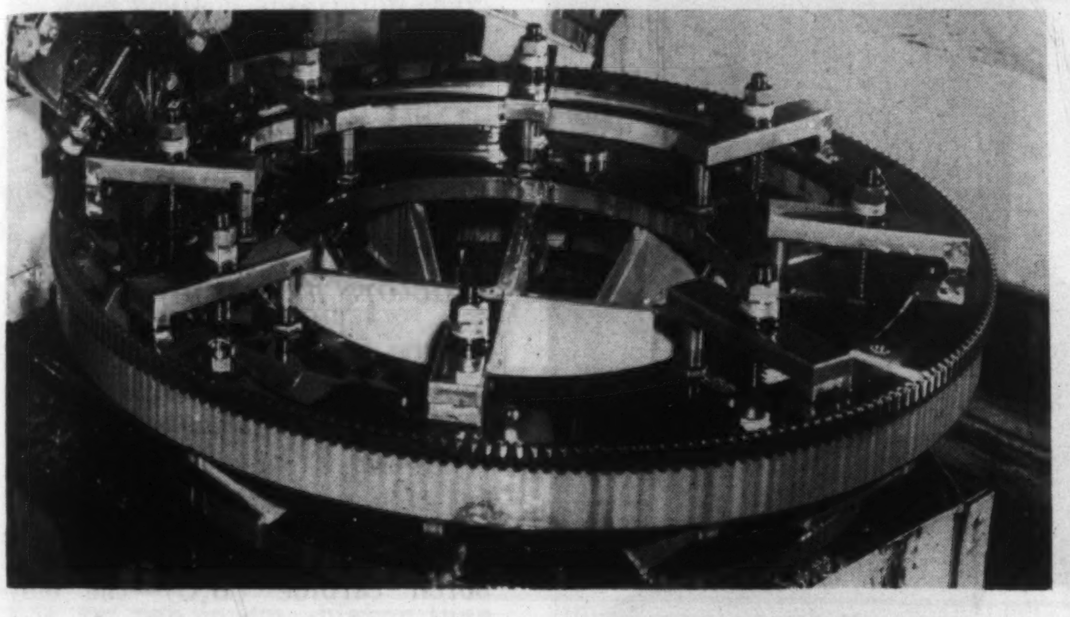
Mechanical properties

Tensile, bend and impact properties of the steels remain essentially unchanged by addition of lead. Properties of a number of grades, given in an accompanying table, compare favorably with those of regular forged and rolled steel rings of equivalent size and grade. Since many gear failures result from surface fatigue, the fatigue properties of these new steels are particularly important.

Published fatigue data comparing leaded and nonleaded steels have been limited. In general they indicate that lead causes a reduction in fatigue strength of 20% for a tensile strength of 265,000 psi, 8% for steels of 150,000 psi, and a negligible reduction for steels of 120,000 psi. Fatigue tests of the reversed bending type, conducted in our laboratories, have

PROPERTIES OF LEADED STEELS

Grade	Section Size, in.	Quench Temp, F	Temper Temp, F	Yld Str, psi	Ten Str, psi	Elong in 2 in., %	Red of Area, %	Brinell Hardness	Charpy Impact Str
10L70	10¾ x 5	1580	1000	104,000	157,000	14.0	26.5	321	10
10L70	14 x 2⅝	1580	1100	87,000	145,000	15.5	37.0	285	14
10L60	13¾ x 8	1580	1100	81,000	142,000	16.5	32.5	269	—
10L50	15¼ x 3	1580	1125	72,500	117,000	22.0	43.5	235	35
10L45	13¼ x 2¾	1580	1125	68,500	110,000	22.0	44.5	229	41
41L30	4½ x 2½	1575	1125	105,000	126,000	18.5	52.1	262	73
41L37	11¼ x 1¼	1575	1250	100,000	122,000	23.5	62.4	248	73
41L40	15 x 6	1575	1175	92,000	118,000	20.0	57.0	235	48
41L40	14 x 2⅝	1575	1100	106,000	132,000	17.5	46.5	277	30
43L40	9¾ x 5	1550	1120	110,000	136,000	17.0	50.7	285	36
43L40	8 x 4¾	1550	1100	125,000	145,000	16.5	47.9	311	28



Machining of Large Gears

not indicated a significant difference between leaded and nonleaded steels heat treated to approximately 145,000 psi. Fatigue tests at higher strength levels are being conducted.

Although insufficient data have been developed to draw conclusive comparisons, results of surface fatigue tests to date favor leaded steel. A grade of high carbon leaded steel, for example, produced definitely improved surface fatigue properties. It was further noted that the work hardening effect, measured by hardness increase, extended to a depth of 0.1 mm in the leaded steel, whereas the hardness increase in the nonleaded steel was limited to a depth of less than 0.02 mm. Similar results have been obtained with 41L40 steel.

The heat treatment response of Hi-Qua-Led is the same as that of a nonleaded steel of the same composition. The presence of lead apparently does not affect carbon penetration or hardness of case hardened, induction hardened or flame hardened components.

Machinability

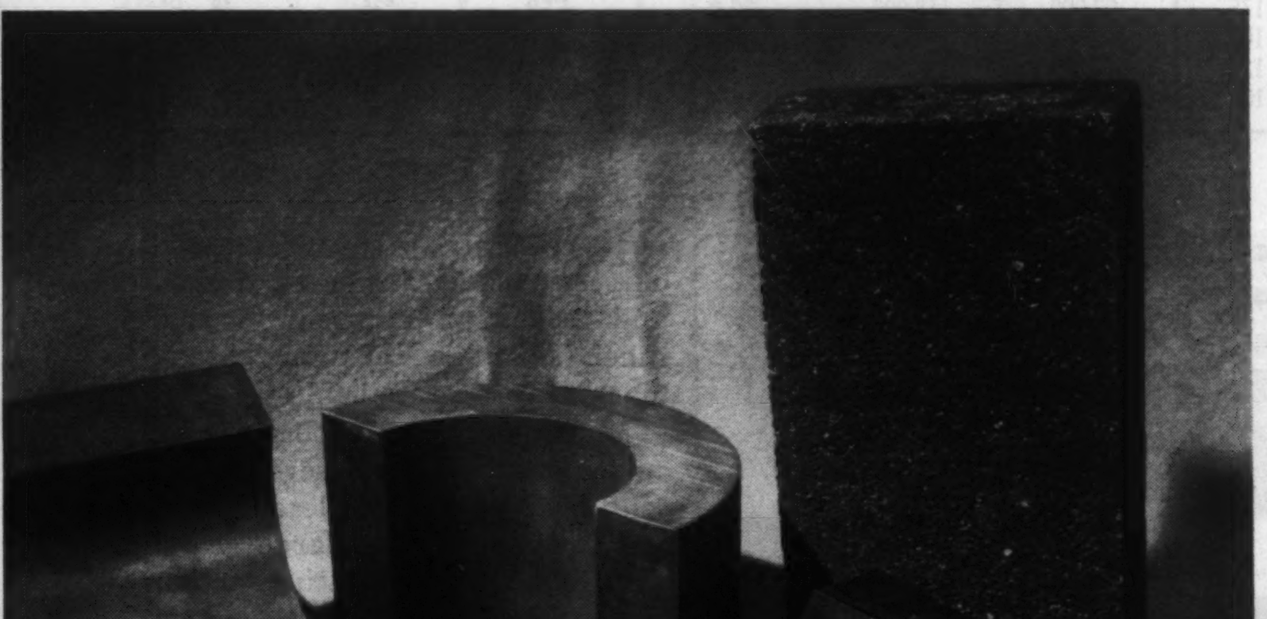
The advantages of lead additives in improving machinability have been demonstrated time and again for a variety of applications. Faster removal of metal is made possible by deeper cuts and faster speeds. Less power is needed to drive the cutting machine, and an improved surface finish is often obtainable with fewer tools, and possibly with lower cost tool steels. In short, leaded steel appears ideally suited to the machining requirements of forged and rolled ring products and other forgings requiring heavy machining operations.

Machinability data obtained by customers reaffirms several potential advantages of leaded steel in the production of large gears. The apparent lubricating action of the lead permits faster speeds and deeper cuts than for nonleaded rings. In one test, turning speed was more than doubled and depth of cut was increased 50%. In another test tool life was increased 1600%. Lead appears to reduce friction between the tool and the part; thus the tools operate at lower temperatures. A deburring operation is often completely eliminated or at least greatly minimized. Sometimes, the use of a roughing tool provides an acceptable surface finish equivalent to that normally obtained with a finishing tool.

A case history—In one actual application, leaded steel was machined successfully with half the normal number of roughing cuts and at greatly increased speeds. Surface finish was greatly improved. Normal surface finish on 4140 steel is 80 to 125 rms, whereas surface finish on the two leaded steel gears was 40 to 60 rms. Total running time per gear was reduced by 12.18 hr, and cutter costs were reduced approximately one-third. Other case histories are given elsewhere on this page.

Boron Carbide Looks Promising for Nuclear Uses

such as . . .



structural parts for reactors

and control rods

Because of its boron content, this hard, stable, lightweight material has a high neutron capture cross section. This article discusses the properties that have led to use of both granular and molded boron carbide in a number of reactors here and abroad.

by Charles W. Henson,
Atomic Products Engineer,
Norton Co.

■ The industrial importance of boron carbide (B_4C)—the only compound in the boron-carbon system—has been primarily due to its extreme hardness. With a Knoop hardness of 2800 (100-gm load), it is the hardest known commercial material next to diamond. Now, as the atomic energy industry grows, boron carbide is being reinvestigated in the light of its other properties and its design potential which make it an interesting material for nuclear engineering.

The importance of boron carbide from the nuclear engineering standpoint lies in its high percentage of boron (78.3%). Elemental boron has a high neutron capture cross section of 750 barns, making it useful for absorbing thermal neutrons in power reactors. By using boron in the form of boron carbide, it is possible to produce structurally strong, corrosion resistant components that combine the good elevated temperature properties and design flexibility of boron carbide with the good neutron absorption characteristics of elemental boron.

Commercial grades

The proportion of boron in boron carbide can be altered, as shown in the accompanying simplified composition diagram. The "technical" grade of boron carbide has a boron content of less than 75% (see left-hand portion of diagram). High purity boron carbide (99+% boron plus carbon) has between 75 and 80% boron, conforming closely with the formula B_4C. Since the density of this type of boron carbide is 2.51 gm per cu cm—higher than that of elemental boron (2.33)—the concentration of boron in high purity boron carbide on a volume basis is 84% of the theoretical value for pure boron.

The right-hand area of the diagram shows enriched grades. They contain 80% or more boron. If the composition is, for example, B_7C (86.3% boron by weight) and the density is 2.47, percentage of boron by volume is about 91.5%. Since the remainder is carbon, a commonly used moderator material, enriched boron carbide can be used in atomic reactors where high concentrations of boron are required. These enriched grades correspond to technical grades of elemental boron. They are relatively costly and not always readily available in large quantities for normal delivery.

Physical properties

The high Knoop hardness of boron carbide is coupled with low weight, extreme chemical stability, high compressive strength and high melting point. On the other hand, boron carbide has a relatively low tensile strength, is quite brittle, and reacts with oxygen to an increasing degree as temperature is increased and particle size decreased. Physical properties are given at right.

Under all ordinary chemical conditions, boron carbide is extremely inert. It is strongly resistant to attack by any chemical other than fused caustic. It reacts quite readily with oxygen at temperatures of about 1800 F, with white hot or molten ferrous metals, and with certain transition metals. Boron carbide can be a hazard to laboratory ware as it also reacts with platinum to produce a low melting boride.

Boron carbide is slowly etched by hydrogen at temperatures of the order of 2200 F, and is attacked slowly by concentrated nitric acid and other powerful oxidizing agents when heated under pressure in a closed vessel. In a carbon monoxide atmosphere, it can be heated to its melting point without change.

Corrosion resistance data are limited. In autoclave tests, specimens show good resistance at 500 F to water which has been degassed and then had oxygen dissolved in it to a concentration of 30 cu cm per l. Corrosion rate reported is −0.12 mg per sq cm per mo. At 600 F, the rate is somewhat higher and some surface roughening is observed.

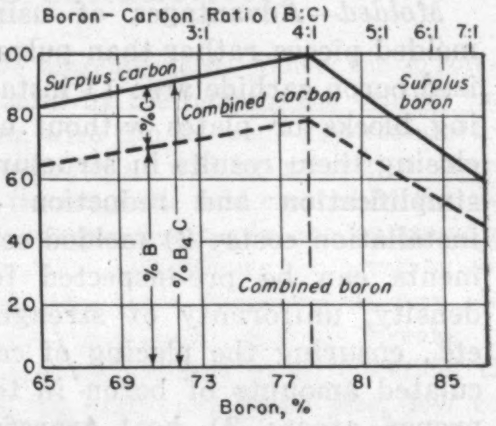
Forms and design

An important characteristic of boron carbide for nuclear reactor use, as well as for general industrial use, is the variety of shapes into which it can be formed.

Granular or powdered—Low cost shields or other types of reactor components can be constructed using mixed sizes of granular boron carbide to fill containers or spaces between walls of a structure. Pertinent design data include boron density, purity and maximum particle size. Boron density in a finished shield is calculated from pack density and percentage of boron in the boron carbide. Maximum particle size is important only where small or constricted spaces must be filled without blocking passages.

PROPERTIES OF BORON CARBIDE (B.C)

Theoretical Boron Content, %	78.3
Melting Point, F	4450
Specific Gravity	2.51
Knoop Hardness, K_{100}	2800
Bending Str, psi	35,000
Compressive Str, psi	414,000
Specific Heat, cal/gm/°C	12.36 (formula mass at 294.3 K)
Coeff of Therm Exp (68-1475 F), per °F	25×10^{-7}
Elec Resist, microhm-cm	$3\text{-}8 \times 10^5$
Refractive Index (red light)	2.66
Young's Modulus, psi	65×10^6 (4.5×10^{12} dynes/sq cm)
Structure	Rhombohedral



Simplified *composition diagram for boron-carbon.*

For pack densities of the order of 1.5 gm per cu cm, so-called run-of mill sizings can be used. These sizings include whatever mesh size is designated as well as all sizes smaller than that designated. For higher pack densities—up to 1.8 gm per cu cm—it is usually necessary to use more expensive special blends of mesh sizes to provide maximum pack density. These are known as vibration or ramming mixtures. In some cases pack densities of 1.9 gm per cu cm can be obtained if the size and geometry of the container or space to be filled are optimum. Where the fill is to be rammed with pneumatic guns, it is usually necessary to add water or other volatile liquid to aid packing.

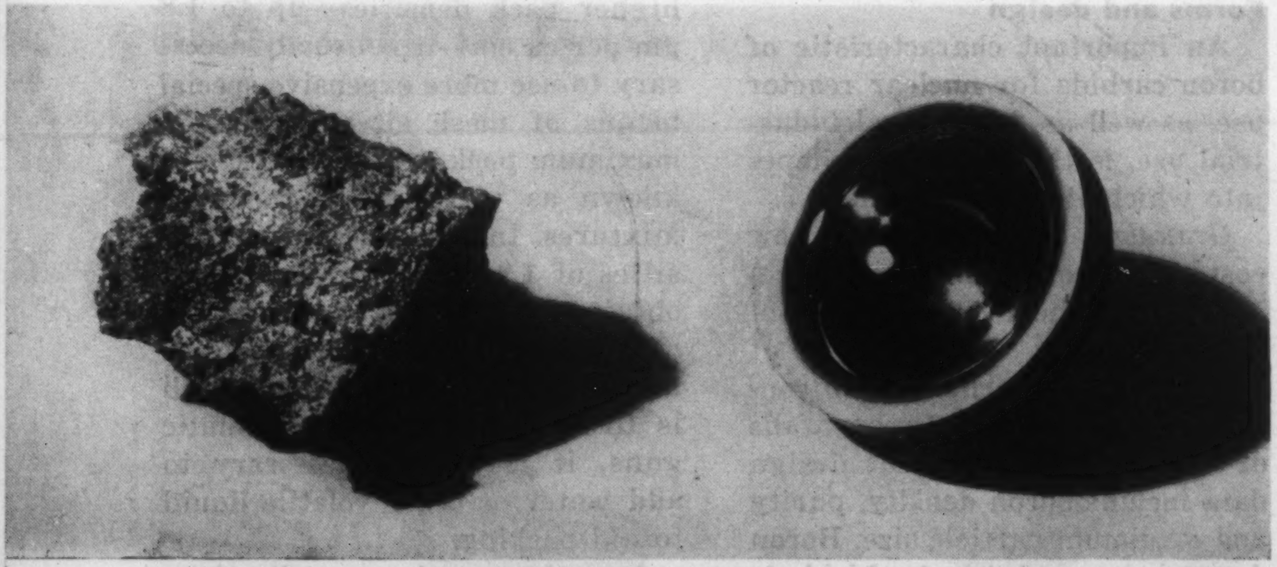
In other nuclear applications where lower boron densities are permissible, pulverized boron carbide can be used as a filler in cements or mortars, in plastics and in metal-bonded and glass-bonded components. The most widely used combination of boron carbide and metal is Boral. A sheet material, Boral is made by suspending size 20-100 boron carbide granules in molten 1100 aluminum. The sheet is formed by casting and rolling, then cladding the filled aluminum on both sizes with aluminum, forming sheets ¼ to ⅛ in. thick. Boron carbide content in the core is usually about 35% by weight.

Molded—Advantages of using molded pieces rather than pulverized boron carbide are: 1) installing blocks or plates without enclosing them results in structural simplification and reduction of installation costs; 2) molded segments can be pre-inspected for density, uniformity of strength, etc., ensuring the placing of calculated amounts of boron in the proper areas; 3) heat transfer characteristics are better and more predictable; and 4) migration of boron carbide grains in event of partitions cracking is avoided.

The process of hot pressing high purity boron carbide powders in graphite molds is relatively well known. It is costly when used to produce wear resistant materials because of the close control of structure and composition necessary. Where technical grades of 67 to 75% boron and bulk densities of 1.8 to 2.3 can be used, cost can be substantially reduced. Cold molding and sintering, a less expensive process, can be used to produce many types of nuclear components.

Advantages of using self-bonded (molded) boron carbide, whether it be hot pressed or cold molded and sintered, lie in high physical strength, high melting point and great resistance to chemical attack. Reactor control elements of this type minimize the danger of boron being dissolved in coolants such as water or sodium should a leak develop.

Where control elements such as round rods must be longer than can be readily pressed or molded, segments in the form of short cylinders can be inserted in tubes to form the desired rod length. When the bulk density of the boron carbide segment is to be about 2.0 to 2.3, size of the cylindrical segments normally falls between ¼ and about 2½ in. o.d. Length of the segments falls between six diameters, in small sizes, and two diameters, in large sizes. Hollow cylinders can be molded where center rods are desirable. Segmental assemblies of rectangular or other form can be produced at densities of 2.0 to 2.3 as long as cross sections are constant to permit compression molding. Where densities of 1.5 to 1.9 can be used, a greater range of sizes and shapes is available. Also, costs are somewhat lower for the lower densities. Chemical stability and strength remain high.



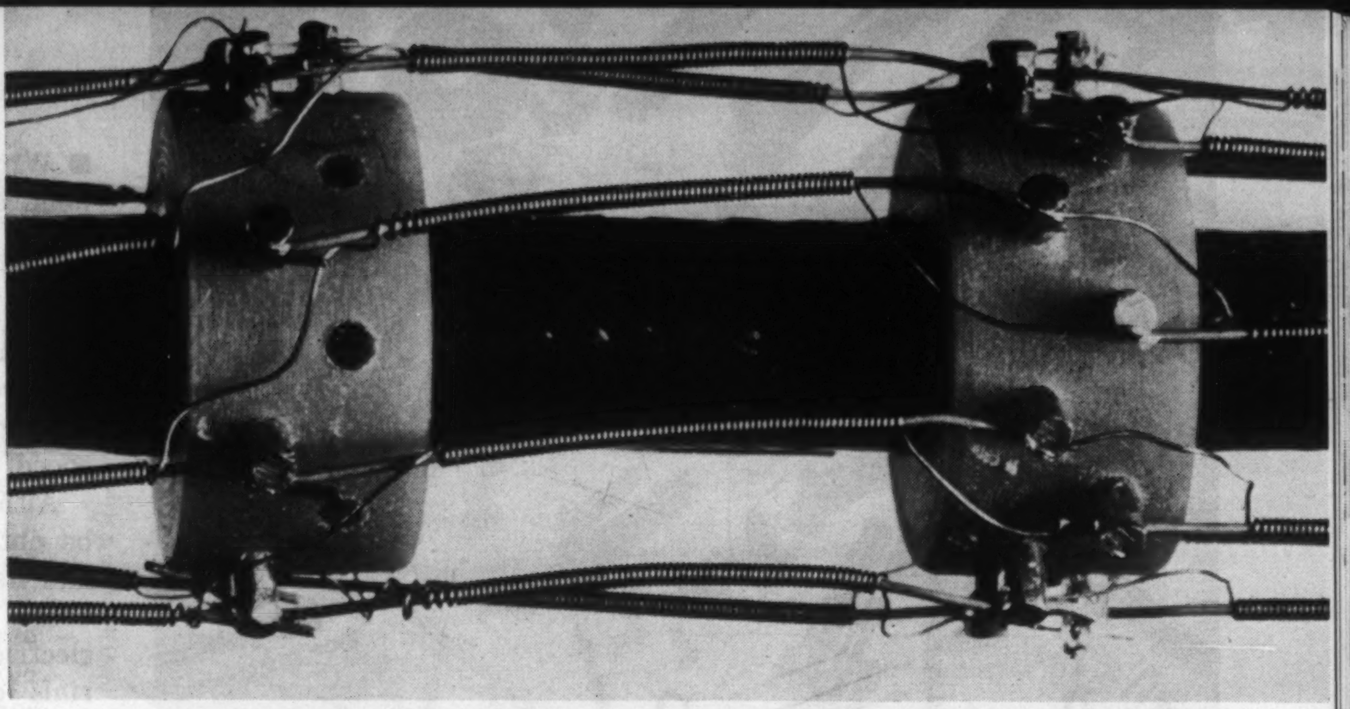
High surface finish *illustrates density of molded boron carbide. Furnace lump of boron carbide is shown at left.*

Molded boron carbide can be finished to precision dimensions by surface grinding. Though diamond wheels are required for centerless grinding or flat surface grinding, shapes with densities of 2.3 and lower do not retain the extreme hardness of wear resistance grades.

Bonded—Where molded boron carbide is to be used at temperatures of not much above 1800 F, ceramic type bonding may be advantageous. Such shapes are less costly then self-bonded boron carbide and have greater design flexibility, since larger and more intricate shapes can be made than are possible by hot pressing or by molding and sintering. One useful composition is obtained by bonding with carbon. The resulting material is analogous to baked carbon products made with coal tar pitch. This type of formulation has the advantage of not introducing additional elements. Other refractory or ceramic bonds include fused sodium silicate or boric oxide and other silicates, borate frits or glassy materials. The best type of bond can be selected only after service conditions such as temperature, load, heat shock and other environmental conditions are determined.

Cermet or metal-bonded boron carbide offers interesting possibilities. Shapes can be made either by powder metallurgy methods or by infiltration of molded boron carbide by molten metal. Most of the work done in this field has been limited to aluminum-bonded products.

For applications at lower temperatures, boron carbide can be bonded with polymeric materials. These include paraffin, rubber, cellulose acetate, acrylics, polyethylene and polystyrene. Compositions containing up to 50% by volume of boron carbide can be formulated. Calendering and compression molding are normal production methods used.



Cryotron: a practical use for superconductivity

A tiny piece of straight tantalum wire (approximately 1/10 in. long) wound with a single layer of columbium control wire (about the size of a human hair) may one day make possible a digital computer system that will occupy only 1 cu ft—representing a space saving of approximately 20 to 1 compared to transistor computers, and perhaps 300 to 1 compared to vacuum tube computers.

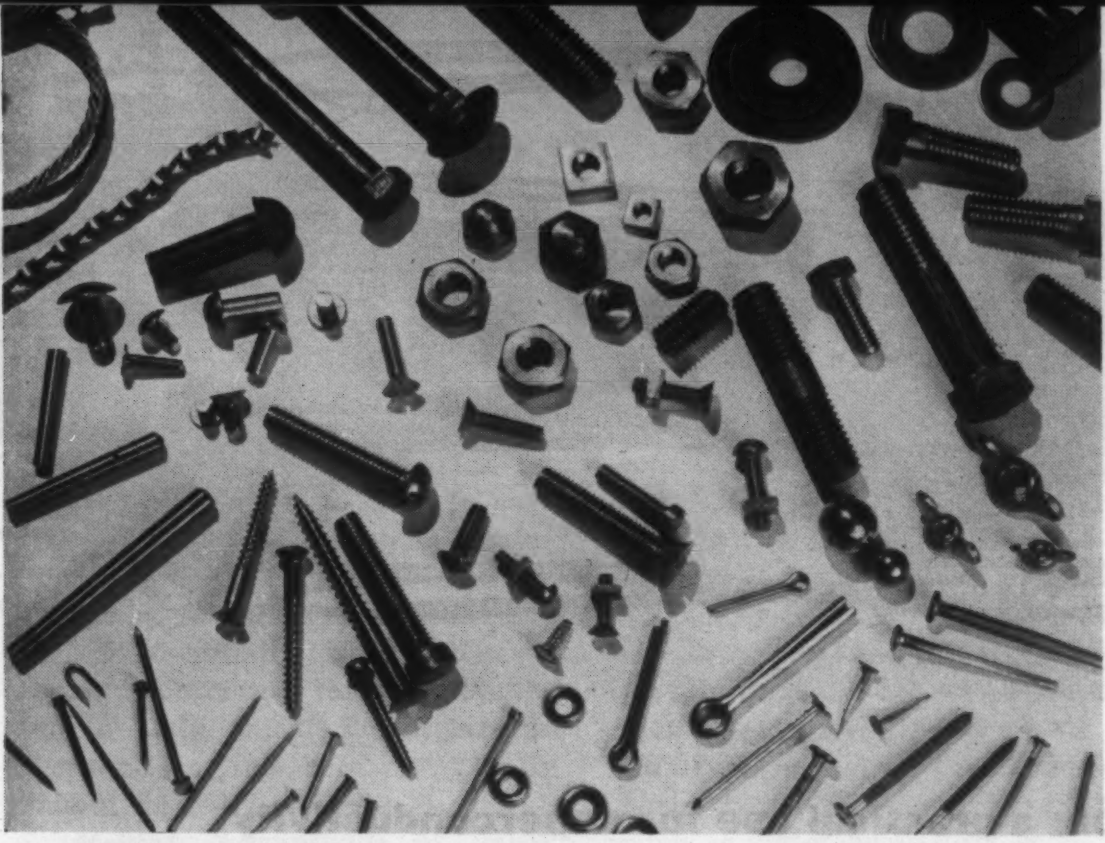
The device, known as the cryotron and developed at Massachusetts Institute of Technology, operates in a bath of liquid helium maintained only a few degrees above absolute zero. When the cryotron is cooled by the helium, the central tantalum wire can be made superconductive or resistive at will by raising or lowering the magnetic field created by the control current flowing in the surrounding columbium coil. Thus, the cryotron performs the same functions as any electronic switch—it makes, breaks or changes connections in an electrical circuit. Its unusually small size, low cost and high reliability make it more attractive than transistors and vacuum tubes for many applications.

MATERIALS AT WORK

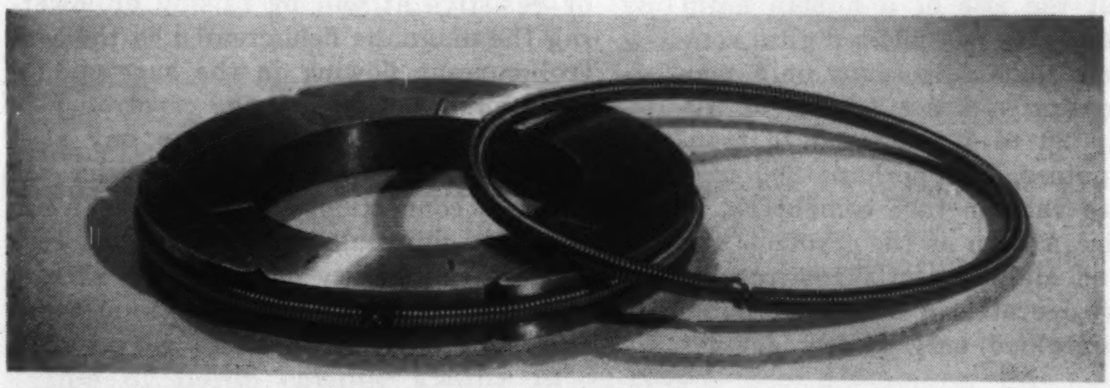
400-lb plastics car

Polyester-glass reinforced plastics moldings are used for the body of this two passenger, three wheel utility car. The car has a top speed of 70 mph and a cruising speed of 40 mph. It is 125 in. long, 49 in. wide and 33 in. high. The car has a 3-gal gasoline tank, but gets 80 miles to the gallon. The two-piece body is mounted on a welded, heavy duty tubular steel frame. A fiberglass blanket insulates the German J.L.O. engine from the driving compartment, and the bucket vinyl upholstery is backed with foam rubber.

Made by Bassons Industries Corp. and priced around $1000, the car has a load capacity of 500 lb. For quick identification when making deliveries, the reinforced plastics body can be made to represent various objects—ice cream cone, liquor bottle, camera, radio or television set.



Screw machine parts *of R Monel. Material has excellent machinability, is tough and resists corrosion and rusting.*



Garter springs *of Inconel have good elevated temperature properties.*

Selecting Nickel Alloy Wire

Nickel, Monel and Inconel wire have good physical properties, good formability and good resistance to heat and corrosion. Here are detailed data and recommendations to help you select the best wire for a specific application.

by David Schmid, *President, Techalloy, Inc.*

■ Wire is one of the most economical forms of metal to use: it can be fabricated by more different methods than any other wrought material; production equipment is less expensive than that required for strip, sheet or tubing; and it lends itself to high speed operation.

Although almost any metal can be obtained in wire form, nickel and its alloys are one of the most useful groups for mechanical and electrical products. These materials combine excellent physical properties with good formability and resistance to temperature and corrosion. All nickel alloys can be readily formed on two-slide and four-slide wire forming machines.

Major types of mechanical products being produced from nickel alloy wire include springs, fasteners, cold headed parts, and woven and welded wire assemblies. In the electrical and electronic fields, the forming characteristics and electrical properties of nickel alloy wire are essential for heating elements, conductors of various types and filaments for vacuum tubes.

Selecting the material

High nickel alloys can be divided into three groups: nickel, Monel and Inconel. Within each of these groups there are several compositions to meet different application requirements. The compositions and general characteristics of the most widely used alloys are listed in Table 1. Detailed design data are given in Tables 2, 3 and 4.

Monel—As shown in these tables, the principal attributes of Monel are its excellent forming characteristics and its corrosion resistance. Although it is one of the lowest strength materials in this group, it has the toughness and strength of low alloy steel and the ductility of mild steel. Furthermore, it retains these mechanical properties over a wider range of temperatures than structural steels.

The strength of Monel can be increased by cold working but not by heat treatment. Tensile strength, as cold drawn, ranges from about 80,000 psi for soft temper to about 165,000 psi for spring temper. Variation of strength and ductility with hardness are shown in Fig 1.

This combination of properties has resulted in the use of Monel wire for a variety of fasteners and other cold headed parts. With proper lubricants, area reductions of 4 to 1 are possible. Where good machining properties are desired as well as adaptability to cold heading, an alloy with higher sulfur content, R Monel, may have advantages. This material is often used instead of brass or bronze because of its better corrosion resistance. It is also used to replace stainless because stainless alloys that can be cold headed are not free machining and those alloys that are free machining cannot be cold headed.

An age hardenable grade, K Monel, has the same corrosion resistance as Monel but possesses higher strength and hardness. It can be hardened from the soft, intermediate or fully cold worked tempers, but optimum properties are attained by heat treating fully cold worked material (Fig 2). Typical applications are valve components, parts for pumps handling corrosive or abrasive liquids, and springs for corrosive environments.

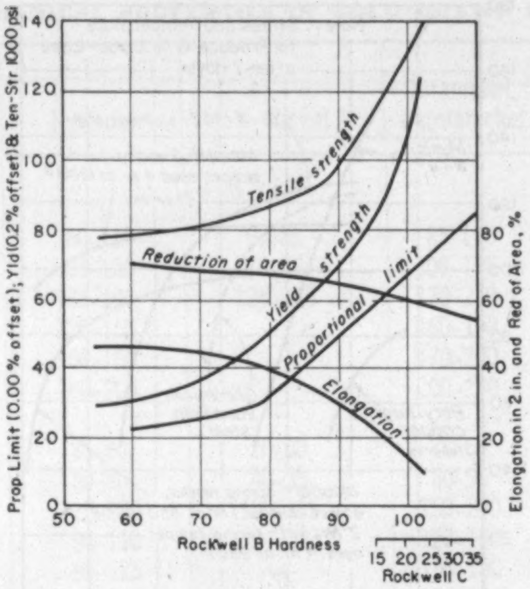


Fig 1—Variation of ductility and strength of Monel with hardness.

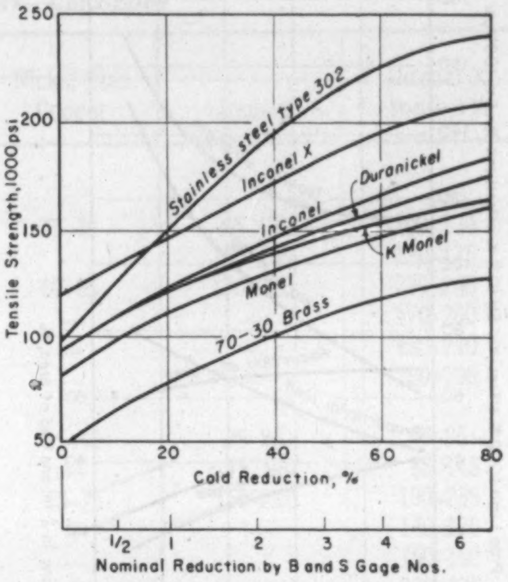


Fig 2—Effect of cold work on the tensile strength of wire.

Nickel — Commercially pure wrought nickel wire is widely used in radio, television and electrical products because it combines good electrical and mechanical properties with resistance to temperature and corrosion. For vacuum tube applications, for example, its ability to release absorbed gases readily while retaining its strength at degassing temperatures above 1000 F is extremely important.

Mechanical properties of wrought nickel are about equal to those of mild steel. Tensile strength, like that of Monel, can be increased by mechanical working but not by heat treating. Ductility can be maintained even

TABLE 1—COMPOSITION AND CHARACTERISTICS OF HIGH NICKEL ALLOYS

Material	Composition, %						Characteristics
	Ni	Fe	Cu	Al	Ti	Other (max)	
Monel	63–70	2.5 max	bal	—	—	Mn 2.0, S 0.024, C 0.30, Si 0.50	General purpose alloy for corrosive applications. Tough, ductile. Has strength of low alloy steel. Good for cold headed parts
R Monel	70 max	2.5 max	bal	—	—	Mn 2.0, C 0.30, Si 0.50, S 0.06	Free machining alloy, particularly useful for parts produced on automatic screw machines
K Monel	63–70	0.9	bal	2.0–4.0	0.25–1.0	Mn 1.50, C 0.25, Si 1.0, S 0.01	Age hardenable alloy for parts requiring higher strength and hardness. Nonmagnetic
Nickel	99.0 min	0.40 max	0.25 max	—	—	Mn 0.35, Si 0.35, C 0.15, S 0.01	Good electrical and thermal conductor. Tough; resistant to corrosion and elevated temperature; magnetic
Duranickel	93.0 min	0.35	0.05	4.0–4.75	0.25–1.0	C 0.30, Si 0.50, Mn 2.0, S 0.024	Higher strength than nickel. Good spring properties up to 600 F. Age hardenable
Permanickel	97.0 min	0.60 max	0.25 max	—	0.60 max	Mn 0.50, C 0.40, Si 0.35, Mg 0.50	Good electrical conductivity. Higher strength and hardness than nickel
Inconel	72.0 min	6.0–1.0	0.05 max	—	—	Cr 17, Si 0.50, C 0.15, S 0.015 Mn 1.0,	Resistant to oxidation and other forms of high temperature attack. Toughness and strength among highest of nickel alloys
Inconel X	70.0 min	5.0–9.0	0.50 max	0.4–1.0	2.25–2.75	Mn 1.0, S 0.01, Si 0.50, Cr 16.0, C 0.08, Cb 1.0	Age hardenable for maximum physical properties. Particularly useful for springs operating at elevated temperatures
Inconel W	70.0 min	5.0–9.0	0.50 max	0.4–1.0	2.00–2.75	Cr 17.0, C 0.08, Mn 1.0, S 0.01 Si 0.70,	Like Inconel X, a good spring material for temperatures up to 1000 F

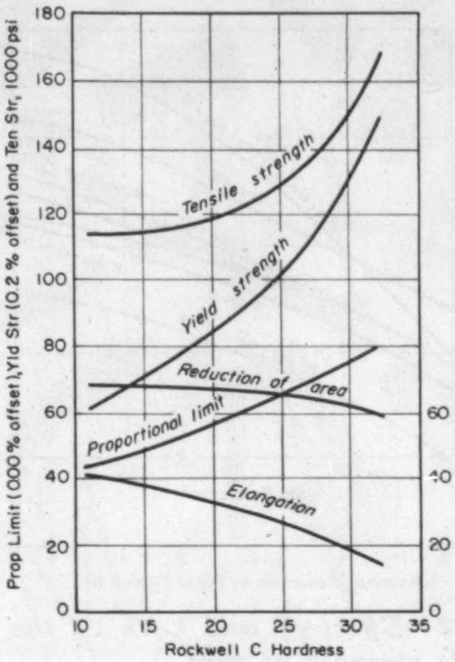


Fig 3—*Ductility and strength of Duranickel vs hardness.*

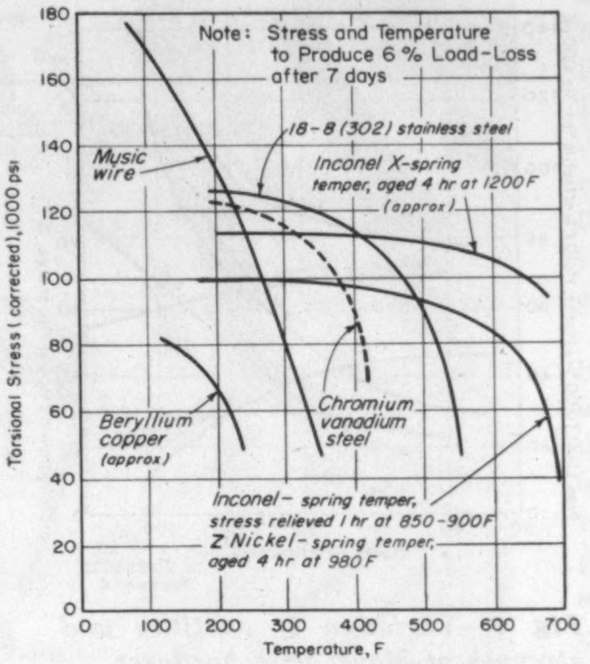


Fig 4—*Comparative relaxation of springs at elevated temperatures.*

in spring tempers and after cold forming.

Where a somewhat higher strength is required, an age hardenable nickel-aluminum-titanium alloy, Duranickel, is available. Tensile strength ranges from about 100,000 psi for soft temper to 180,000 psi for spring temper. As shown in Fig 3, ductility and toughness decrease with increasing hardness, but the wire does not become brittle even at a tensile strength of 200,000 psi.

A nickel - magnesium - titanium alloy, Permanickel, combines the mechanical properties of Duranickel with the electrical conductivity of pure nickel. This wire is particularly useful for current-carrying springs, high strength electrical conductors, vacuum tube

TABLE 2—MECHANICAL PROPERTIES OF COLD DRAWN WIRE

Property	Monel, R Monel	K Monel	Nickel	Duranickel, Permanickel	Nickel-Clad Copper	Inconel	Inconel X, Inconel W
Wire Dia: 0.002-0.010 in.							
Ten Str, 1000 psi:							
Annealed	85–110	—	60–95	100–150	40–70	105–135	130–160
Full Hard-Spring	160–210	—	135–160	225–260	—	185–250	245–275
Annealed, Age Hardened	—	—	—	170–200	—	—	180–210
Spring, Age Hardened	—	—	—	250–280	—	—	280–310
Yld Str, 1000 psi:							
Annealed	40–65	—	20–60	50–110	20–50	45–80	70–125
Full Hard-Spring	140–200	—	115–150	210–250	—	165–240	225–265
Annealed, Age Hardened	—	—	—	140–170	—	—	150–180
Spring, Age Hardened	—	—	—	230–260	—	—	250–280
Elongation, %:							
Annealed	40–25	—	50–15	35–10	10 min	40–20	35–10
Full Hard-Spring	5–2	—	5–2	5–2	—	5–2	5–2
Annealed, Age Hardened	—	—	—	20–8	—	—	—
Spring, Age Hardened	—	—	—	8–3	—	—	—
Wire Dia: 0.010-0.032 in.							
Ten Str, 1000 psi:							
Annealed	70–95	95–115	60–95	95–125	40–70	90–130	130–160
No. 1 Temper	85–100	100–125	90–105	110–140	—	120–160	135–185
Full Hard-Spring	145–180	155–195	125–150	175–225	—	180–230	220–250
Annealed, Age Hardened	—	130–150	—	160–190	—	—	180–210
No. 1 Temper, Age Hardened	—	140–170	—	170–200	—	—	190–220
Spring, Age Hardened	—	175–210	—	220–250	—	—	270–300
Yld Str, 1000 psi:							
Annealed	30–55	40–65	25–55	40–85	20–50	40–85	65–110
No. 1 Temper	50–75	55–80	50–75	70–100	—	75–115	85–135
Full Hard-Spring	125–170	130–185	105–140	155–210	—	150–210	190–230
Annealed, Age Hardened	—	90–110	—	120–150	—	—	150–180
No. 1 Temper, Age Hardened	—	100–130	—	130–160	—	—	160–190
Spring, Age Hardened	—	150–200	—	200–230	—	—	240–280
Elongation, %:							
Annealed	45–25	40–20	50–25	40–15	30–10	45–20	35–15
No. 1 Temper	30–20	30–15	30–15	30–10	—	30–10	25–10
Full Hard-Spring	5–3	5–2	5–2	5–2	—	5–2	5–2
Annealed, Age Hardened	—	30–15	—	20–10	—	—	20–10
No. 1 Temper, Age Hardened	—	25–10	—	15–8	—	—	15–8
Spring, Age Hardened	—	8–3	—	8–3	—	—	8–3

TABLE 2—MECHANICAL PROPERTIES OF COLD DRAWN WIRE—Continued

Property	Monel, R Monel	K Monel	Nickel	Duranickel, Permanickel	Nickel-Clad Copper	Inconel	Inconel X, Inconel W
Wire Dia: 0.032-0.0625 in.							
Ten Str, 1000 psi:							
Annealed	70–95	80–110	55–85	85–115	35–60	85–130	100–130
No. 1 Temper	85–100	95–120	70–95	100–135	—	120–155	130–175
Full Hard-Spring	145–180	145–190	125–145	170–210	60–85	170–220	210–245
Annealed, Age Hardened	—	120–150	—	160–190	—	—	170–200
No. 1 Temper, Age Hardened	—	130–160	—	170–200	—	—	180–210
Spring, Age Hardened	—	160–200	—	200–240	—	—	260–295
Yld Str, 1000 psi.							
Annealed	30–55	35–60	20–50	35–65	15–40	35–85	45–85
No. 1 Temper	50–75	50–80	40–75	60–95	—	75–120	85–145
Full Hard-Spring	125–170	125–180	105–135	150–200	50–75	150–210	190–235
Annealed, Age Hardened	—	90–110	—	120–150	—	—	140–170
No. 1 Temper, Age Hardened	—	95–125	—	150–180	—	—	150–180
Spring, Age Hardened	—	140–190	—	180–220	—	—	230–275
Elongation, %:							
Annealed	45–25	40–20	50-30	40–20	40–20	45–25	40–15
No. 1 Temper	30–20	30–15	40–20	30–15	—	30–15	25–10
Full Hard-Spring	5–2	5–2	5–2	5–2	5–2	5–2	5–2
Annealed, Age Hardened	—	30–15	—	25–10	—	—	20–10
No. 1 Temper, Age Hardened	—	25–10	—	20–8	—	—	15–8
Spring, Age Hardened	—	8–3	—	10–5	—	—	8–3
Wire Dia: 0.0625-0.250 in.							
Ten Str, 1000 psi:							
Annealed	70–95	80–105	50–85	75–100	30–60	80–120	95–130
No. 1 Temper	75–100	95–120	70–90	95–120	—	105–135	130–170
Full Hard-Spring	130–160	150–185	100-130	160–200	55–85	170–220	185–230
Annealed, Age Hardened	—	120–150	—	150–180	—	—	170–200
No. 1 Temper, Age Hardened	—	130–160	—	160–190	—	—	180–210
Spring, Age Hardened	—	160–200	—	200–240	—	—	250–290
Yld Str, 1000 psi:							
Annealed	30–60	35–65	20–50	35–65	15–40	35–75	40–80
No. 1 Temper	40–70	50–95	40–60	60–95	—	70–105	75–135
Full Hard-Spring	120–150	135–180	100–125	150–195	50–75	150–210	170–220
Annealed, Age Hardened	—	90–110	—	110–140	—	—	140–170
No. 1 Temper, Age Hardened	—	95–125	—	120–150	—	—	150–180
Spring, Age Hardened	—	140–190	—	180–220	—	—	230–270
Elongation, %:							
Annealed	45–25	40–20	50–30	40–20	40–20	45–20	40–15
No. 1 Temper	30–20	30–15	40–20	30–15	—	35–15	30–10
Full Hard-Spring	5–2	5–2	5-2	5–2	5–2	5–2	5–2
Annealed, Age Hardened	—	30–15	—	25–10	—	—	20–10
No. 1 Temper-Age Hardened	—	25–10	—	20–8	—	—	15–8
Spring, Age Hardened	—	8–3	—	10–5	—	—	8–3

grids, and highly stressed magnetostrictive units.

One material that is currently finding new applications is nickel-clad copper wire (see M&M, May '52, p 96). The copper core carries the current and the nickel or Inconel cladding protects the core from oxidation and other damage from high temperatures. Such a material makes possible durable electrical leads that are smaller than could be produced with a single material. Inconel-clad nickel and stainless-clad copper wire are under development.

Inconel—When wire with maximum strength and resistance to temperature is needed, one of the three Inconel alloys should be used. Tensile strength of Inconel ranges from 100,000 psi for soft temper to 175,000-200,000 psi for spring temper. It can be increased by cold working but not by heat treatment. Low yield strength (30,000 to 50,000 psi) and good elongation (35 to 50%) facilitate fabrication of the wire in the temper condition.

As a spring material, Inconel offers low relaxation at temperatures up to 650 F. Music wire and other spring steels cannot be used above 250 and 425 F, respectively (see Fig 4). Maximum operating temperatures for various spring wires are given in Table 5.

For higher strength and resistance to temperatures up to 1000 F, Inconel X or W should be used. As shown in Table 1, both have the same analysis with the exception of columbium, and they can be used interchangeably. Both alloys can be fabricated by most conventional techniques. Forming in the pre-age hardened condition is recommended.

Spring wire for use at temperatures up to 800 F is hardened by heating at 1200 F for 4 hr, followed by air or furnace cooling. For spring applications between 800 and 1000 F, No. 1 temper wire (130,000 psi tensile strength) is used and is age hardened at 1350 F for 16 hr. Maximum design stress for Inconel X or W is 100,000 psi—about the same as for music wire.

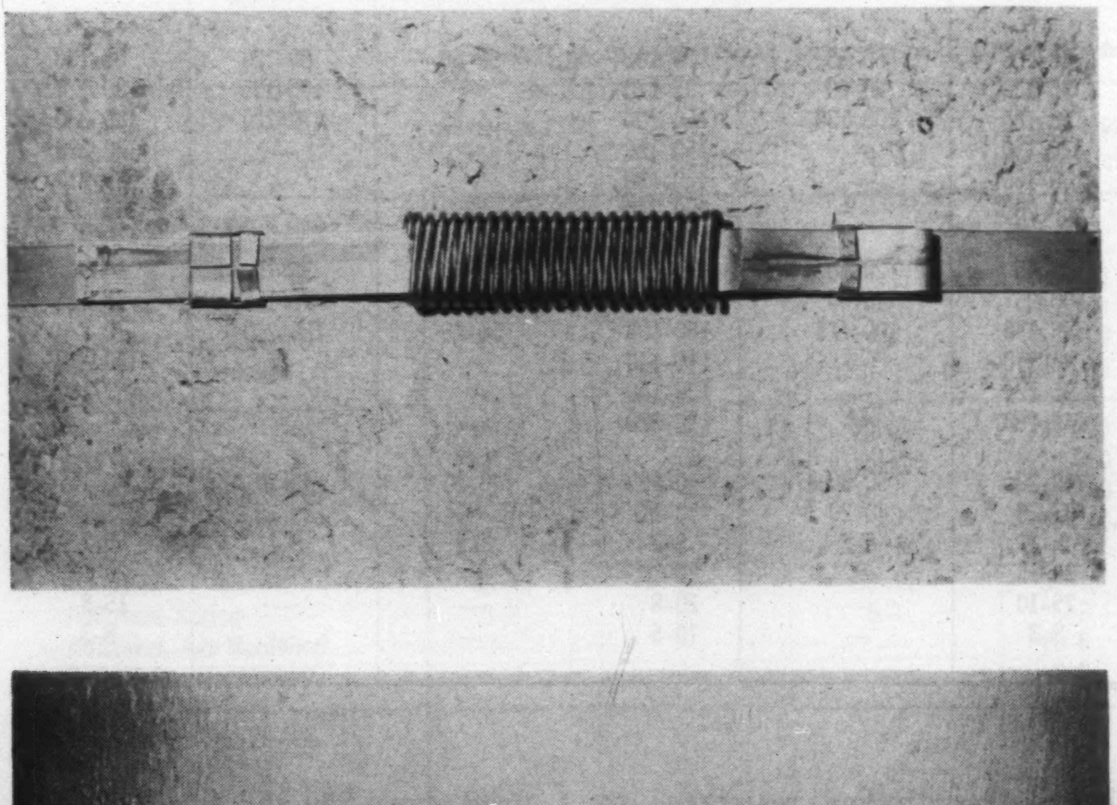
Other considerations

Tolerances—Typical commercial tolerances for nickel alloy wire are given in Table 6. Closer tolerances, one half or less of the values listed, can be met, but they will require paying a premium price for the material.

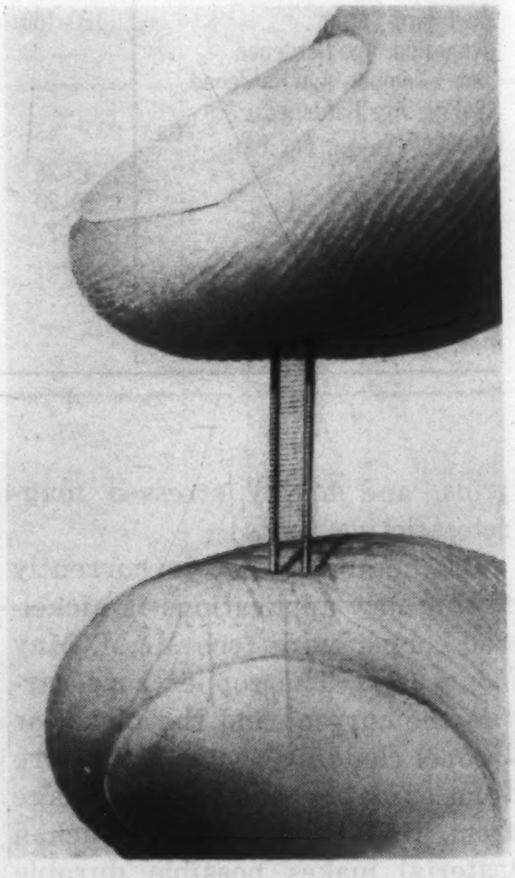
Finish—Surface finishes that can be expected from cold drawn stock range from 10 to 64 microinches rms, depending upon condition of dies, drawing speed, and lubricant. For most applications, this range is adequate, but finer finishes can be obtained at increased cost. Inconel spring wire should be purchased with a lead

Some Tips on Buying Wire

1. Give supplier complete data on mechanical properties required.
2. List maximum and minimum limits for properties wherever possible.
3. Tell supplier end use of material. Include maximum and minimum temperatures and corrosive atmospheres, if any. The supplier may be able to suggest a lower-cost alloy based on other customers' experiences.
4. Describe fabricating procedures and equipment in your plant; you may get material at no added cost that has been specifically prepared for your needs.
5. Specify surface finish requirements accurately.
6. Specify ductility requirements to avoid breakage during processing of the wire into finished product.
7. Specify spools or coils.
8. Investigate possibility of getting wire cut to exact length and straightened. In some applications reduced waste will more than offset increased initial materials costs.



Breather springs *of K Monel or Inconel provide necessary elongation and contraction in steel bands used to hold thermal insulation on metal tanks, towers, etc. They are corrosion resistant and maintain strength and elasticity at high temperatures.*



Ladder-type grid *with legs of 0.015-in. nickel wire wrapped with 0.0001-in. gold plated tungsten wire is free of kinks, cracks and nicks. Use of these materials reduced grid rejects by over 50% in one case.*

coating to minimize the tendency to gall.

Shape—Though standard round wire is best suited for most applications, almost any shape wire can be obtained to meet special requirements. Some of the most widely used shapes are shown in Fig 5. Use of special shapes may provide advantages such as: 1) savings in material, 2) reduced processing and faster production, 3) increased structural strength per pound of wire, and 4) improved product appearance. The use of hexagon stock for small bolts is a typical example of how material can be saved.

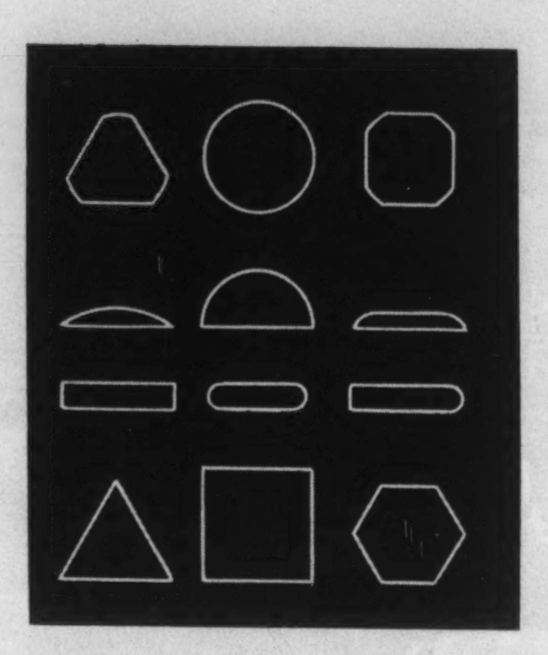


***Fig 5**—Typical wire shapes—round and special.*

Avoid Contamination

All of the materials mentioned in this article can be joined by brazing, soft soldering, gas or electric welding without sacrificing corrosion resistance. However, cleanliness in these operations is of particular importance because at high temperatures nickel alloys are subject to attack by sulfur and low melting metals, especially lead. Sulfur combines with nickel to form a brittle sulfide which cracks when stressed. Lead acts in a similar manner. Thus, when annealing or bonding with heat, care must be taken to remove all material which might contain either of these elements. For best results, zinc chloride-base fluxes are generally preferred.

TABLE 3—COMPARISON OF TENSILE AND TORSIONAL PROPERTIES OF HIGH NICKEL ALLOY WIRE

Alloy	Condition	Dia, in.	Tensile Properties		Torsional Properties		Ratios		
			Min Ten Str (ASTM Spec), 1000 psi	Ten Str, 1000 psi	Break Str, 1000 psi	Prop Limit, 1000 psi	Tor Break Str/Ten Str	Tor Prop Limit/Ten Str	Tor Prop Limit/Tor Break Str
Monel	Cold drawn 75%	0.148	140	157	110	68	0.700	0.433	0.618
	Cold drawn 75%, stress relieved	0.148	140	160	105	65	0.656	0.404	0.619
Inconel	Cold drawn 65%	0.148	170	172	115	74	0.669	0.430	0.643
	Cold drawn 65%, stress relieved	0.148	170	188	124	77	0.659	0.410	0.620
K Monel	Cold drawn 50%	0.148	150	163	107	68	0.657	0.417	0.635
	Cold drawn 50%, age hardened	0.148	170	197	137	75	0.696	0.380	0.547
Duranickel	Cold drawn 50%	0.148	155	175	127	71	0.725	0.406	0.560
	Cold drawn 50%, age hardened	0.148	190	225	160	76	0.712	0.338	0.475

TABLE 4—ENDURANCE LIMITS AND EFFECT OF CORROSION ON FATIGUE[a]

Material	Condition	Endurance Limit in Air, psi	Apparent Corrosion Fatigue Limit[c], psi		
			Fresh Water	Sea Water	Distilled Water
Monel	Cold drawn, stress equalized 3 hr at 800 F	52,000	—	—	—
	Annealed 1 hr at 1400 F	34,000	29,000	29,000	—
K Monel	Cold drawn	45,500	—	—	25,000
	Hot rolled, aged 16 hr at 1080 F	49,000	—	—	29,000
Duranickel	Cold drawn, aged 16 hr at 1080 F	51,000	37,500	28,000	—
	Hot rolled, aged 16 hr at 1080 F	52,000	—	—	35,000
Inconel	Hot rolled	42,500	—	—	33,500
	Cold drawn, stress equalized 1 hr at 900 F	45,000	—	—	—

[a] All values based on 10^8 cycles.

[b] Bar stock, 10,000 rpm, polished specimens.

[c] Corrosion fatigue tests do not take into account the time factor to any appreciable extent.

TABLE 5—TEMPERATURE LIMITS OF SPRING WIRE

Material	Max Recommended Temp, F
Hard Drawn Steel (SAE 1350, 1360)	400
Music Wire (SAE 1085, 1090)	250
Chromium-Vanadium Steel (SAE 6150)	425
Stainless, Type 302	550
Stainless, Type 414	450
Inconel	650
K Monel	450
Duranickel, Age Hardened	650
Inconel X, Spring Temper, Aged 4 hr at 1200 F	800
Inconel X, Spring Temper, Aged 16 hr at 1350 F	1000

TABLE 6—STANDARD TOLERANCES FOR ROUND WIRE[a]

Wire Size, in.	Tolerances, in. ±
0.002 –0.0043	0.0002
0.0045–0.0077	0.00025
0.008 –0.0145	0.0003
0.015 –0.0195	0.0004
0.020 –0.031	0.0005
0.032 –0.045	0.0006
0.046 –0.079	0.0007
0.080 –0.1875	0.001
0.1875–0.406	0.001–0.002
0.406 –0.500	0.002

[a] Cold drawn material in coils or straight lengths.

Krylon, Inc.

***Clear acrylic spray** applied to delicate electronic equipment provides moisture resistance and assures retention of electrical calibrations during storage.*

Acrylic Coatings for Metal Products

Clear lacquers and pigmented enamels are used to:

1. *Preserve attractive metallic surfaces*
2. *Protect electronic circuits from moisture*
3. *Protect chemical and food processing equipment*
4. *Provide a finish that maintains its color at elevated temperatures*

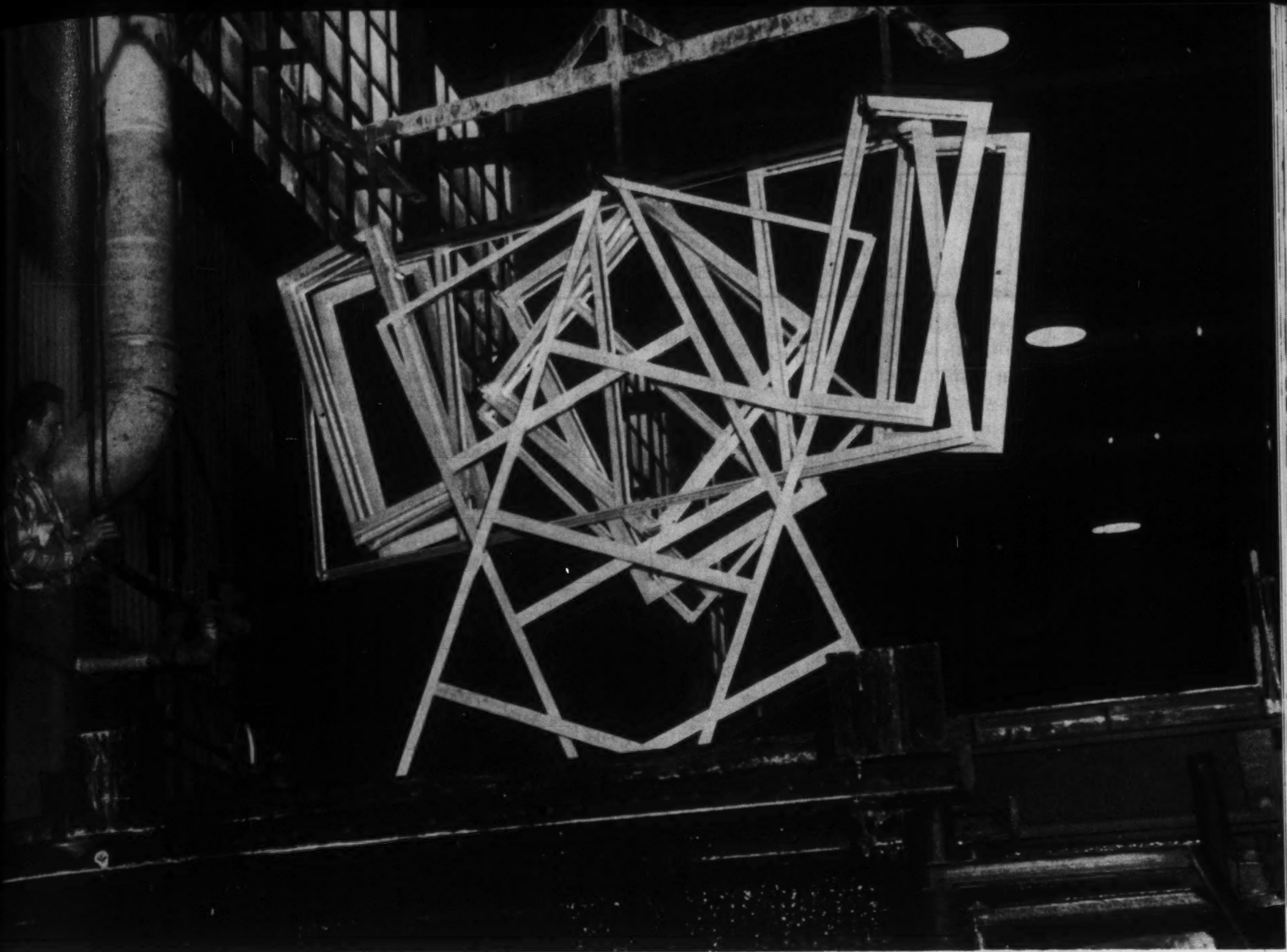
Here is a summary of the properties and applications of these versatile coatings.

by Gerould Allyn, *Rohm & Haas Co.*

■ Acrylic coatings—based on a class of polymers or synthetic resins known as acrylic and methacrylic esters—have a wide range of properties, depending largely on the polymers used. Since these polymers are related to Plexiglas and Lucite, it is not suprising to find that they can be used to produce films that are tough and durable in outdoor as well as indoor applications.

Clear coatings

Typical properties of unmodified acrylic polymers are presented



Michael Flynn Mfg. Co.

***Aluminum sash** is removed after dip in clear protective acrylic lacquer.*

in Table 1. Good adhesion can be obtained on brass, copper, aluminum, steel, chromium plate, zinc die castings and other metals. Acrylic coatings have good resistance to dilute acids, alkalis and mineral oils. They are permanently soluble in strong solvents such as ketones and esters, and to a lesser degree in aromatic hydrocarbons.

Clear acrylic coatings are normally supplied with a 15 to 20% solids content and are usually reduced about 25% for spray application. For dip application, a lower solids content—achieved by a 1:1 reduction—is often used.

Films set to touch in 5 to 10 min and dry tack-free in 10 min to 1 hr. Sward hardness ranges from 20 to 30. Clear acrylic films are thermoplastic and become tacky at about 200 F; however, original hardness is recovered upon cooling. Flexibility is reduced at low temperatures but the films are not harmed.

Cost of acrylic coatings is somewhat higher than that of conventional oil- or alkyd-base coatings. Assuming a delivered price of

TABLE 1—TYPICAL PROPERTIES OF ACRYLIC RESIN FILMS

Film Type[a] Property	A	B	C	D
Tensile Strength, psi	4100	2900	2900	2200
Ultimate Elongation, %	3	44	77	64
Toughness, in.-lb per cu. in.	60	1000	2000	1200
Dielectric Constant:				
60 cycles	3.6	4.4	4.7	3.2
1000 cycles	3.2	3.7	4.1	2.8
10^6 cycles	3.1	3.1	3.3	2.6
30×10^6 cycles	2.3	2.6	2.9	2.3
Power Factor, %:				
60 cycles	7.1	9.6	8.8	9.0
1000 cycles	3.5	7.8	8.0	5.6
10^6 cycles	3.0	4.6	5.7	2.3
30×10^6 cycles	27.5	6.8	9.8	9.5

[a] Letters A through D represent Acryloid (Rohm & Hass Co.) A-101, B-72, B-82 and F-10, respectively.

TABLE 2—COMPARATIVE PROPERTIES OF ACRYLIC, UREA-ALKYD AND PORCELAIN ENAMELS

Property	Acrylic Enamel	Urea-Alkyd Enamel		Porcelain Enamel	
		250 F Bake	350 F Bake	Medium Gloss, Acid Resistant	High Gloss
Pencil Hardness	8H+	3H	3H	8H+	8H+
Gloss	High	Medium	medium	Poor	Fair-Poor
Print Temperature	200 F	300 F+	300 F+	Very High	Very High
Falling Ball Impact, ft	8	8	8	5	7
Heat Resistance:					
350 F	Excellent	Poor	Poor	Excellent	Excellent
400 F	Good	Poor	Poor	Excellent	Excellent
Abrasion Resistance:					
Frosting, sec	5	2	3	50	100
Wear-Through, min	13	30	30	30	30
Chemical Resistance:					
Water	Good	Fair	Fair	Good	Good
1% Sodium Hydroxide	Good	Poor	Poor	Fair	Fair
5% Acetic Acid	Good	Poor	Poor	Dull	Dull
Ethyl Alcohol	Poor	Fair	Poor	Good	Good
Mineral Oil	Good	Good	Good	Good	Good
Recovery From Exposure to:					
Water	Good	Good	Good	Good	Good
1% Sodium Hydroxide	Good	Fair	Fair	Good	Good
5% Acetic Acid	Good	Good	Good	Poor	Poor
Ethanol	Fair	Good	Good	Good	Good
Mineral Oil	Good	Good	Good	Good	Good

TABLE 3—PROPERTIES OF THREE WHITE ACRYLIC ENAMEL FILMS

Property	Very Hard Base	Hard Base	Moderately Soft Base
Hardness after 30 min at 300 F:			
Pencil	3H	H	F
Tukon	29.2	13.3	15.0
Gloss:			
Visual	3	2	1
Photovolt, %	83.0	83.5	83.0
Gloss retention, %:			
After 16 hr at 350 F	71.0	79.0	81.0
After 16 hr at 400 F	72.0	13.5	14.0
Color retention[a]:			
Initial	6.8	6.1	6.1
After 16 hr at 350 F	7.2	14.0	22.0
After 16 hr at 400 F	8.9	81.6	121.0
Adhesion:			
Knife	Fair	Good	Good
Micronknife[a]	16.3	5.19	3.83
Flexibility (effect of binding over ⅛-in. mandrel):			
Initial	Cracked	Very tiny cracks	Very tiny cracks
After 16 hr at 400 F	Cracked	Cracked	Cracked
Gasoline resistance (effect of immersion)	Very slightly softened	Very soft, partly dissolved	Very soft, partly dissolved
Water resistance (effect of immersion):			
3 wk at 77 F	No effect	No effect	No effect
16 hr at 165 F	No loss in gloss, very slight rusting	Flat, moderate rusting	Flat, moderate rusting
Soap resistance (effect of immersion in water solution 24 hr at 165 F)	No effect	Etched, discolored	Etched, discolored

[a] Low values best.

$2.50 per gal for clear acrylic coatings, the materials cost of dry coatings is about $10 per 1000 sq ft per mil. However, films considerably thinner than 1 mil are normally used for most applications.

Because of their invisibility and their resistance to atmospheric fumes and moisture, clear acrylic coatings are especially useful as protective finishes over polished metals. Acrylic coatings provide valuable protection for brass or bronze parts, which have a tendency to lose their sparkle fairly rapidly, and various silverware items such as candlesticks, trophies and plaques. The coatings are also used to prevent staining of aluminum window and door frames, curtain walls and other structural shapes by mortar, plaster and stucco.

Clear and pigmented coatings are used in the vacuum metallizing process to provide both a base coat and a protective and decorative coating for the metallic deposit. The base coat is needed to provide a smooth surface, since the thin metallized film tends to reproduce exactly the surface on which it is deposited. (In the case of plastics parts, the base coat also seals the surface and prevents outgassing of plasticizers that might otherwise occur under vacuum.) The top coat, in addition to protecting the metallized film from abrasion, can be used to change the color of the finish.

Aluminum is by far the most commonly used metal for metallizing and as deposited it has the appearance of a polished white metal such as silver or chromium. A wide range of metals can be simulated, however, by means of pigmented or dyed acrylic coatings.

Electronic equipment is frequently given an acrylic aerosol spray coating to provide resistance to fungus, moisture and dilute acids. This treatment provides protection against breakdown during tropical exposure and helps to preserve delicate calibrations in electronic circuits. Spray coatings are often applied to high voltage leads of television sets to eliminate corona, a frequent cause of "snow" on the screen. Clear acrylic coatings are also used to seal splices in communications cables—both underground and overhead—in order to provide moisture and weather protection.

Similar coatings are used to provide a protective and decorative finish for aluminum foil. Coatings may be used clear or else treated with transparent dyes for novelty packaging effects.

Clear acrylic coatings can be used to protect chromium plate when the nickel underplate has to be reduced or eliminated because of a nickel shortage. Automobile manufacturers have used this type of coating extensively for protecting chromium plated bumpers.

Acrylic enamels

Acrylic resins provide a good base for pigmented enamels. Since they are not reactive with pigments, color retention is excellent even at elevated temperatures. This property is particularly important for industrial coatings on such items as electrical heaters, kitchen stoves, hospital sterilizers and fluorescent lighting fixtures.

The strong solvents required to thin acrylic paints have a tendency to lift coats of conventional oil paints or primers, so special primers are often required. Some acrylic paints permit the use of xylol or toluol thinners and some require ketone solvents such as methyl ethyl ketone. A few specialized coatings, intended chiefly for brush application, may be thinned with mineral spirits or turpentine.

Since they are not reactive with conventional paint pigments, acrylic polymers can be formulated in a multitude of colors. Coatings can be either air dried or baked. No oxidation is needed to form the film since the coatings dry by solvent evaporation. Force drying is often desirable, however, to speed up production and to improve adhesion, gloss and hardness. Application is generally by spray gun, aerosol spray, dip or flow coating. However, tumbling, roller coating and brushing can also be used.

A comparison of the properties of an acrylic enamel with those of other white enamels—urea-alkyd and porcelain—is given in Table 2. Table 3 presents complete data on three acrylic enamels made with three different bases varying from very hard to moderately soft. Cost of these coatings ranges from $3 to $7 per gal depending on the properties desired. On this basis, the materials cost of dry coatings ranges from $7.50 to $17.50 per 1000 sq ft per mil.

Acrylic enamels modified with silicone polymers can be used to protect parts operating in the range of 300 to 500 F. At these temperatures oil-based coatings quickly decompose but acrylic-silicone enamels retain their film properties and color remarkably well. Acrylic-silicone enamels are considerably more expensive than unmodified coatings. They are normally applied by spray and baked for about 1 hr at 400 to 480 F.

First in a Series

This is the first in a series of articles on synthetic resin-base coatings for metal products. Other articles in the series will cover such coatings as the phenolics, the epoxies, the vinyls and the silicones.

Applications of acrylic enamels in protecting and decorating metal surfaces are numerous. Since acrylic resin solutions do not react with or discolor powdered metals, they can be mixed directly with powdered aluminum, bronze, or stainless steel. The resulting ready-to-use enamels do away with two-part systems and provide simulated metallic surfaces with maximum brilliance.

Tough and flexible modified acrylic finishes can be applied to metal sheet prior to stamping or forming. This technique is used extensively in the manufacture of aluminum awnings.

Within the past year acrylic finishes have replaced conventional nitrocellulose lacquers on some automobile bodies. It is too early to obtain a final evaluation of these finishes, but accelerated tests in Florida indicate that the acrylic finishes retain their color and gloss considerably better than nitrocellulose lacquers.

Acrylic enamels are also widely used on machinery and equipment that is exposed to chemical fumes and fruit juices. Modification with chlorinated rubber provides an unusually tough, resistant coating. For good adhesion, a rust inhibiting primer should be used.

Other coatings

Acrylic polymers are used for many specialty coatings. Each of these coatings utilizes one or more of the unique properties inherent in the acrylic resins. Luminescent type coatings, for example, are commonly made with acrylic bases because the neutral acrylic polymer does not react with sensitive fluorescent and phosphorescent pigments. For added visibility, a white acrylic base coat should be applied before application of the luminescent coating. After a thorough drying period, a clear acrylic top coat is applied for added protection.

Some progress is being made in developing water-base acrylic primers for metals. Water-thinned acrylic primers are not combustible in liquid form and provide a major reduction in fire hazards. Primers have been developed in red iron oxide automotive and in white refrigerator types. These primers possess good adhesion and salt spray resistance and must be baked to develop their best properties. Gloss enamels made from water-based acrylic polymers have not yet proved practical.

Acknowledgment

The special assistance provided by the following companies in preparing this article is gratefully acknowledged:

Cosden Paint Co.
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Products Research Service, Inc.
Red Spot Paint & Varnish Co.

MATERIALS AT WORK

Neoprene caps prevent pipe corrosion

With the introduction of a new type of roll-on end cap made of neoprene, the inside of expensive alloy tube stock can be efficiently and inexpensively protected from corrosion during storage.

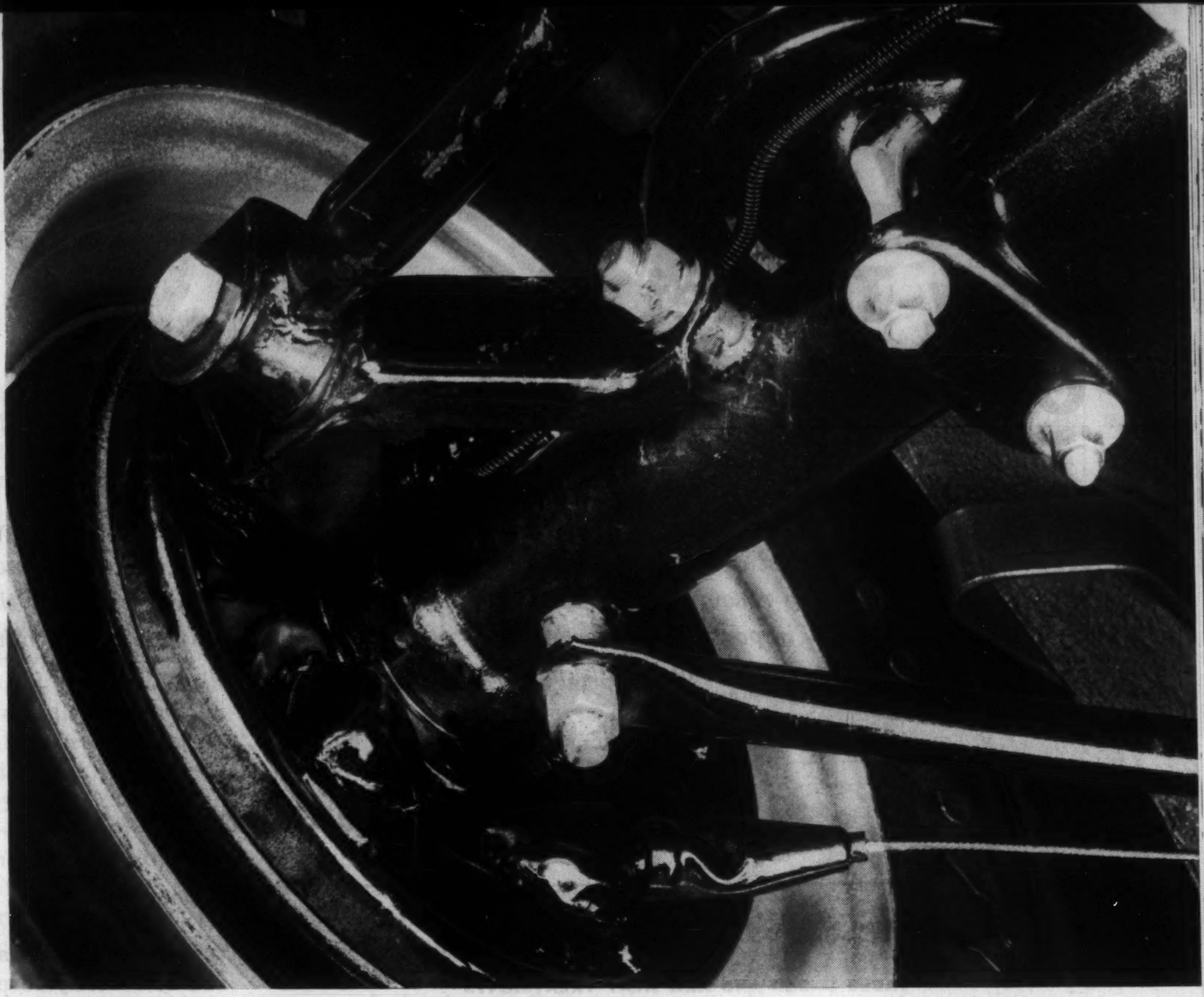
The caps, currently available for pipe from 2 to 20 in. in dia, effectively seal out moisture, fumes, dust, sand, grit and rodents. They are resistant to acids, oil, sunlight and weathering. The caps are made by Protokap, Inc.

Lightweight conveyor belt made of Mylar

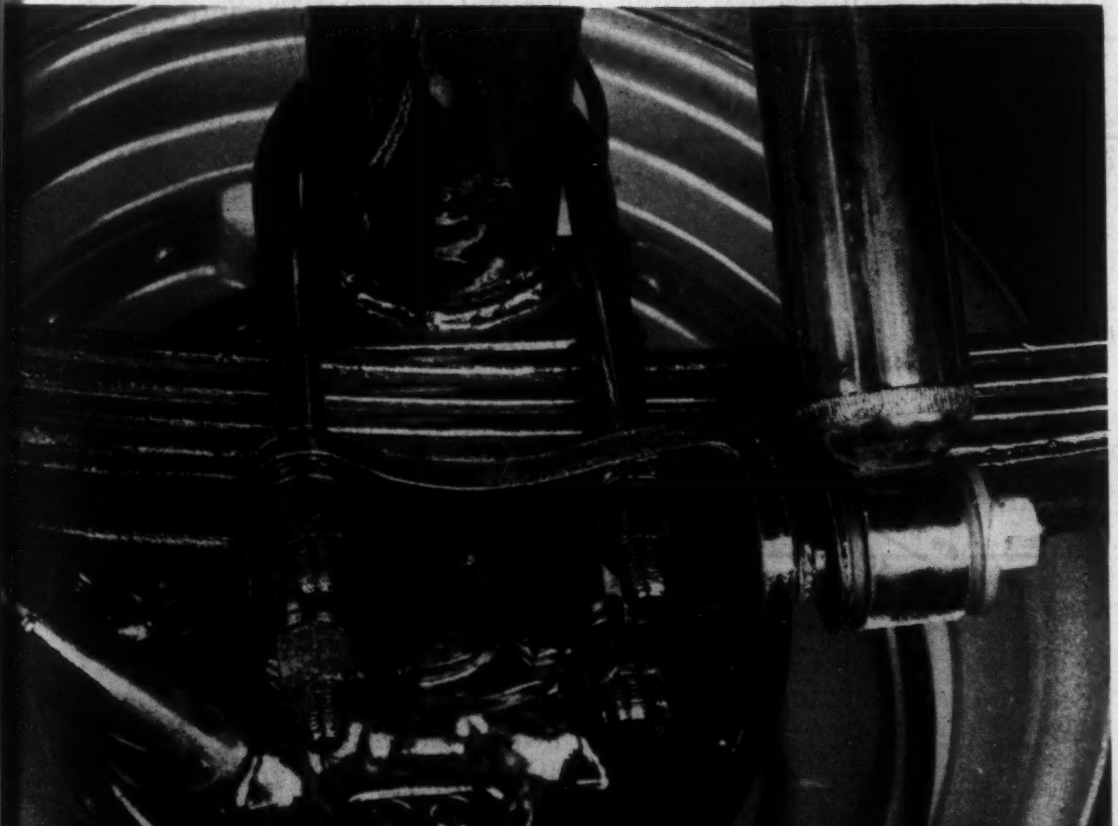
These doughnuts, on their way to be coated with sugar, are traveling on a conveyor belt made of Mylar polyester film. The belt weighs only 0.04 lb per sq ft (one-twelfth as heavy as the lightest woven material), yet is exceptionally strong. It is also smooth, flexible, crackproof, nonabsorbent, immune to attack by acids and greases, stable under temperature and humidity changes, and a good heat transfer agent.

The belt, which can be easily installed, is fabricated by joining two 3-mil sheets of transparent Mylar film with a special white adhesive. The ends are left open a few inches; when the belt is fitted to the conveyor the ends are dovetailed and sealed with a brush-applied adhesive. Pressure sensitive tape with a backing of Mylar completes the smooth finish.

The Mylar belt, made by Mohawk Supply Co., is presently being used in over 100 companies in the candy, baking and other food processing industries. It is expected to find application in pharmaceutical houses, tobacco operations, rubber product manufacturing and chemical plants where strength and good release properties are required.



End welded studs fasten auto axle assembly



These two end welded shoulder studs (above) are being used on the rear axle tubes of Nash and Hudson cars. The lower stud is a truss rod anchor, replacing a forging that required hand welding, drilling and tapping. The stud at top center holds a bracket, also bolted to the flange of the tube, which secures the sway bar.

The ¾-in. studs are welded to the axle tube with a single gun production unit manufactured by Nelson Stud Welding Div., Gregory Industries, Inc. Once the cycle is started, by pushbutton or foot switch, the gun moves automatically into position, welds the stud and retracts.

A special ¾-in. shoulder stud (left) serves as anchor pin for the shock absorber. This use of welded studs is the first of its kind in the automotive field. The shock absorber plate (center), to which the stud is end welded, holds the leaf spring to the axle by means of two U-bolts placed over the axle.

by **John T. Richards,** *Chief Engineer, Penn Precision Products, Inc.*

How To Get More Out of Beryllium Copper

An extensive and continuing test program has developed much new information on beryllium copper. Of greatest practical importance, perhaps, are changes in the recommended standard heat treatments. Also important, however, are new data on how the properties of beryllium copper are influenced by such factors as beryllium content, rolled temper, aging temperature, heating rate during aging, metal thickness and grain direction. This article explains the new heat treatments and summarizes the other data that have been obtained.

Use New Heat Treatments

The changes . . .

TABLE 1—OLD AND NEW HEAT TREATMENTS

Temper and Designation	Old Treatment[a]	New Treatment
Solution Treated (soft)—A	3 hr at 600 F	3 hr at 650 F
Quarter Hard—¼ H	2½ hr at 600 F	3 hr at 625 F
Half Hard—½ H	2 hr at 600 F	2 hr at 625 F
Hard—H	2 hr at 600 F	2 hr at 625 F

[a] In accordance with ASTM B194 and Federal QQ-C-533 specifications.

and the results . . .

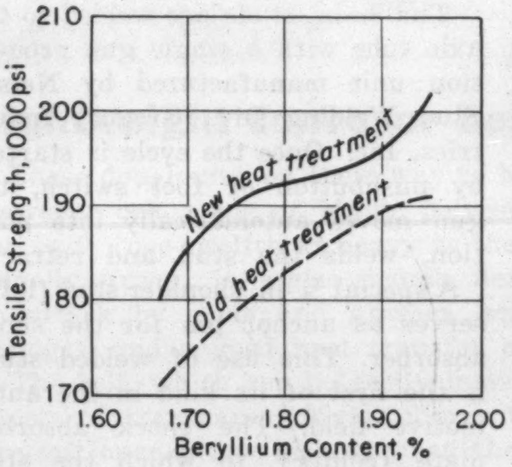


Fig 1—*Comparison of old and new heat treatments for varying beryllium contents.*

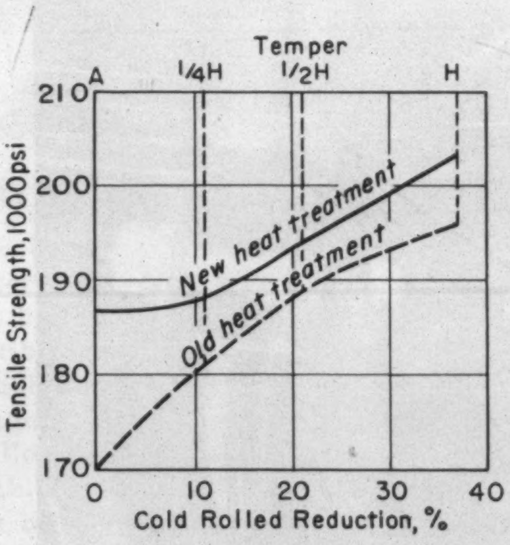


Fig 2—*Comparison of old and new heat treatments for varying cold rolled tempers prior to aging (beryllium content 1.90%).*

Beryllium copper is frequently selected because of its ability to respond to heat treatment. Parts can be severely formed in a relatively soft condition, then age hardened to give the required combination of properties. Recently substantial improvements have been made in beryllium copper. The improved properties, achieved by certain changes in composition (notably a reduction in impurity levels and a decrease in beryllium content), include: ductility, formability, machinability, electrical and thermal conductivities, resistance to moderately elevated temperatures, and stability. With these improvements, however, it became necessary to change the standard heat treatments in order to obtain optimum properties.

Table 1 lists both the old and the new heat treatments. Fig 1 and 2 show how the new heat treatments improve tensile strength. The new treatments are relatively simple and are not critical with respect to time or temperature. Their effectiveness has been proved in use, and they can be depended upon to give maximum properties in most applications. In some instances, however, the desire for special property combinations or certain processing techniques necessitates the use of special treatments. Some of these variations will be discussed in connection with the data presented in the remainder of this article.

Use New Data

The work that led to changes in the standard heat treatments has also clarified the influence of several factors on the properties of beryllium copper. These factors are discussed below and illustrated in the accompanying graphs, Fig 3 through 7.

Beryllium content—As expected, higher strengths are developed from increased beryllium contents. However, alloys with high beryllium contents reach a hardness or tensile peak in shorter time than alloys having less beryllium. Consequently, overaging takes place more rapidly in high beryllium material. Since these differences are slight, the effect of beryllium content need only be considered in critical applications requiring high temperature heat treatment (675 or 700 F).

Rolled temper—Fig 3 shows the influence of cold rolled temper prior to aging upon hardness response at 625 F. As indicated, an increase in temper results in higher tensile properties and shortens the time required to reach peak properties. This means that half-hard (½H) material requires less heat treating time to reach maximum properties than solution treated (A) strip. In the case of substantially overaged strip, however, the hardening effect of cold rolling is removed by stress relieving, so added temper may offer no advantage in final properties.

Aging temperature—The effect of aging temperature is important. Although the new treatments given in Table 1 frequently offer the best combination of properties, there are applications for which it may be desirable to employ either higher or lower temperatures than those recommended. In fixture work, for example, higher aging temperatures may be required to obtain the degree of stress relief needed. In addition, higher temperatures offer shorter aging cycles, thereby increasing heat treating capacity as well as production rates. The influence of aging temperature is shown in Fig 4 for half-hard (½H) material. Note that though slightly higher properties are obtained with the lower aging temperatures, they are achieved only through considerable sacrifice in heat treating time. Table 2 lists typical properties resulting from aging times selected to give approximately maximum strength for various aging temperatures.

Heating rate—The rate of heating, as well as the uniformity, will, of course, vary for different types of furnaces. Salt baths, muffle furnaces and circulating air furnaces are used. At lower aging temperatures, variations in heating can be frequently neglected; but at higher aging temperatures, where time is critical, they must be considered. The furnace charge and type of loading must also be taken into account, since large charges will require more heat-up time than a few parts scattered throughout the furnace.

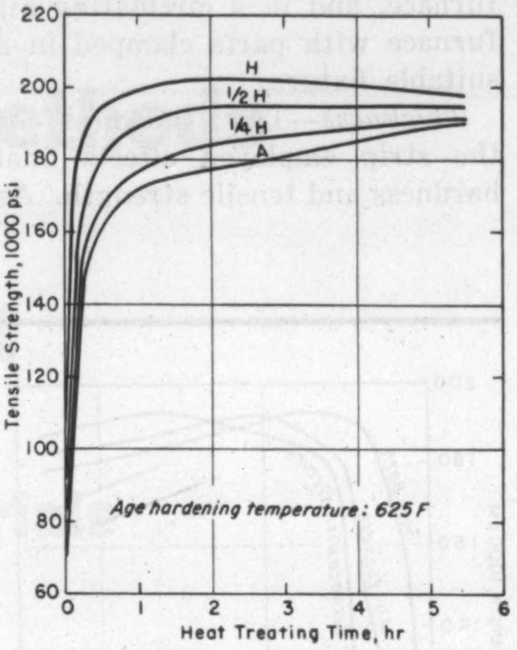


Fig 3—*Effect of prior cold rolled temper upon age hardening at 625 F.*

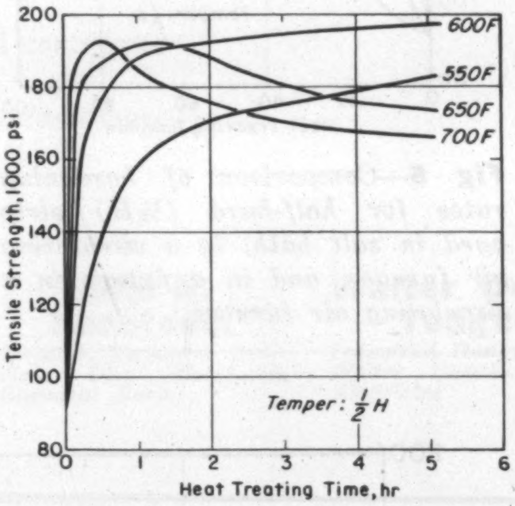


Fig 4—*Influence of aging temperature upon strength of half-hard (½H) beryllium copper strip.*

It is sometimes desirable to heat treat beryllium copper in a fixture in order to attain dimensional tolerances that are not otherwise possible. The mass of the fixture may influence the heating rate and must be taken into consideration. Fig 5 compares hardening rates obtained in a salt bath, in a circulating air

TABLE 2—TENSILE STRENGTHS RESULTING FROM OPTIMUM AGING TIMES

Aging Temp, F	Solution Treated—A		Quarter Hard—¼ H		Half Hard—½ H		Hard—H	
	Optimum Aging Time	Ten Str, 1000 psi	Optimum Aging Time	Ten Str, 1000 psi	Optimum Aging Time	Ten Str, 1000 psi	Optimum Aging Time	Ten Str, 1000 psi
Unaged	—	69	—	81	—	91	—	106
600	8 hr	180	6 hr	191	5 hr	197	4 hr	204
625	5 hr	189	3 hr	189	2½ hr	198	2 hr	202
650	3 hr	188	2 hr	188	1¼ hr	193	1 hr	197
675	1¼ hr	184	1¼ hr	188	½ hr	194	25 min	199
700	½ hr	184	½ hr	185	25 min	190	15 min	196

furnace, and in a circulating air furnace with parts clamped in a suitable fixture.

Thickness—The thickness of the strip employed affects final hardness and tensile strength. As indicated in Fig 6, a decrease in thickness generally produces an increase in strength for a given temper. Since this effect is not great, it will not influence processing techniques, but it should be recognized from a design standpoint. Conceivably, higher stress levels could be permitted in parts using thin strip.

The limitations of the hardness test, with respect to thickness, must also be recognized. The increase in tensile strength that has been observed in the thinner gages may not be accompanied by a corresponding increase in hardness. In fact, a superficial hardness test will frequently show a decrease in hardness although the strength has actually increased. Therefore, caution should be exercised when using the hardness test as an inspection procedure for strip material under 0.015 in. thick.

Grain direction—The influence of grain direction upon the mechanical properties of beryllium copper strip may frequently be of practical significance. Unfortunately, many engineers mistakenly assume that the properties of strip materials are universally inferior in the transverse direction (across the strip at 90 deg to the rolling direction). The assumption is not valid for many strip materials. In the case of beryllium copper, tests conducted 45 deg and 90 deg to the rolling direction reveal an increase in strength. Provided formability is not a factor, parts can be safely blanked in the 45- or 90-deg directions with no sacrifice in strength.

Fig 7 indicates the influence of grain direction upon certain mechanical properties. Prior to aging, grain direction has little effect on material rolled half hard (½H). After heat treating, however, mechanical properties in the transverse direction are definitely improved. (Note, however, that the modulus of elasticity in all cases is greater across the strip than along it. The difference of approximately 1 million psi may be significant from the design standpoint if a part is blanked across, rather than along, the rolling direction.) In the case of lower tempers, such as solution treated (A) or quarter hard (¼H), directionality can generally be ignored.

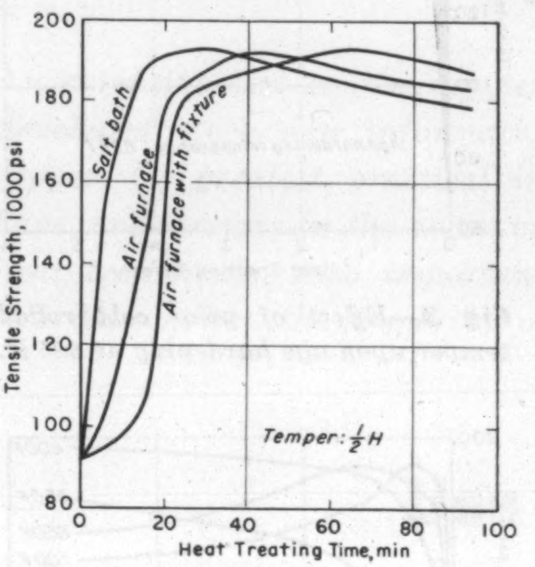


Fig 5—*Comparison of hardening rates for half-hard (½H) strip aged in salt bath, in a circulating air furnace, and in a fixture in a circulating air furnace.*

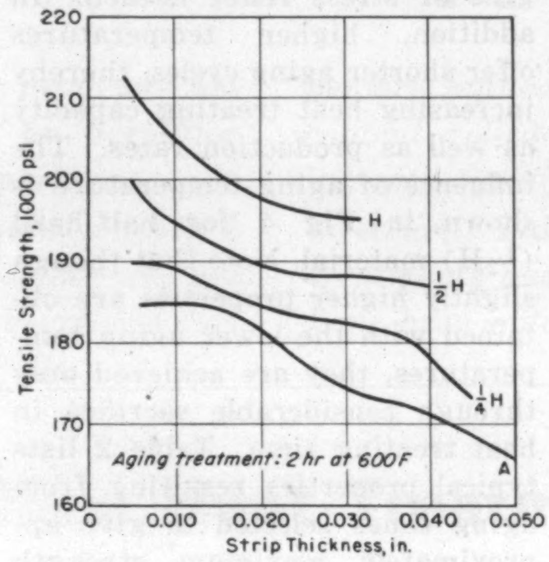


Fig 6—*Effect of strip thickness upon strength of various tempers of beryllium copper strip aged 2 hr at 600 F.*

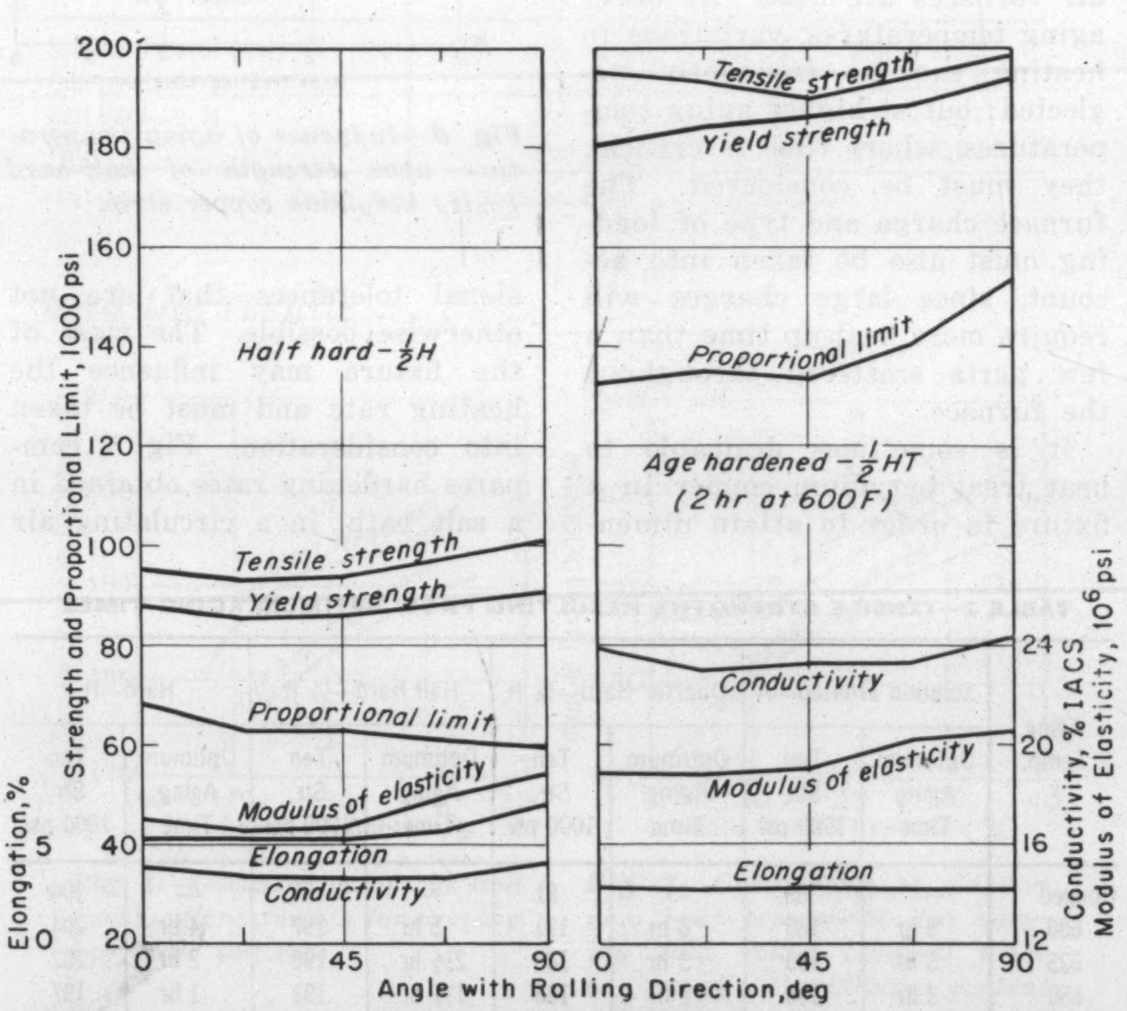


Fig 7—*Influence of grain direction upon beryllium copper strip in the half-hard (½H) and age hardened (½HT) conditions.*

Enter the

Materials & Methods AWARDS COMPETITION

for the

Best Use of Materials in Product Design

SIXTEEN AWARDS

The best entries selected by the judges will receive awards as follows:

First Award	**$500**	*and plaque*
Five Awards of Merit	**$100**	*each and certificate*
Ten Citations	**$50**	*each and certificate*

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Walter Dorwin Teague, *Industrial Designer, Walter Dorwin Teague Associates*

Who may enter

Any person, persons, organization or consultants serving in the product manufacturing industries may submit an entry or entries. Anyone employed by materials producers and suppliers is not eligible.

What may be entered

Entries may be either a new product or a redesigned product that demonstrates sound, imaginative and progressive use of engineering materials. Engineering materials are defined as metals, nonmetallics, finishes and coatings, and material forms (such as castings, forgings, moldings, fabricated shapes, etc.). The product may be a complete assembly, a subassembly, or a single part. See next page for details on the information that must be submitted with each entry.

When to submit entries

Any product(s) whose design or redesign was completed during the calendar year of 1956 may be entered. Entries must be mailed no later than January 31, 1957. Mail all entries to Awards Editor, Materials & Methods, 430 Park Avenue, New York 22, New York.

(continued on next page)

How to prepare your entries

Entries need not be written up in the form of an article. They will not be judged for literary quality. However, the following information must be provided with each entry in order to allow the judges to make competent decisions.

1. A detailed description of the product including photographs or drawings. If the entry is a redesign, provide before and after illustrations if possible.
2. A description of requirements in service and/or fabrication that must be met by the product and the material.
3. A description of the previously used materials (if entry is a redesign).
4. A description of the material or materials selected for the product.
5. An explanation of why the material or materials were selected for the product. Describe the advantages or benefits gained through the choice. Back them up with evidence—facts, data, charts, tables on performance, quality or cost.

In general, entries should show that the materials selected for the product—

1. Resulted in improved performance and/or lower costs

or

2. Best met the design and service requirements.

Here are a few specific ways in which a product can benefit from intelligent materials selection:

Longer service life
Lower basic materials costs
Less material required
Improved appearance
Permitted a new design
Reduced production costs

Improved service performance
Reduced scrap
Reduced or eliminated maintenance
Permitted lower cost design
Allowed greater design flexibility
Simplified production and fabrication

Remember! The more detailed and documented your entry is, the more consideration it will receive from the judges.

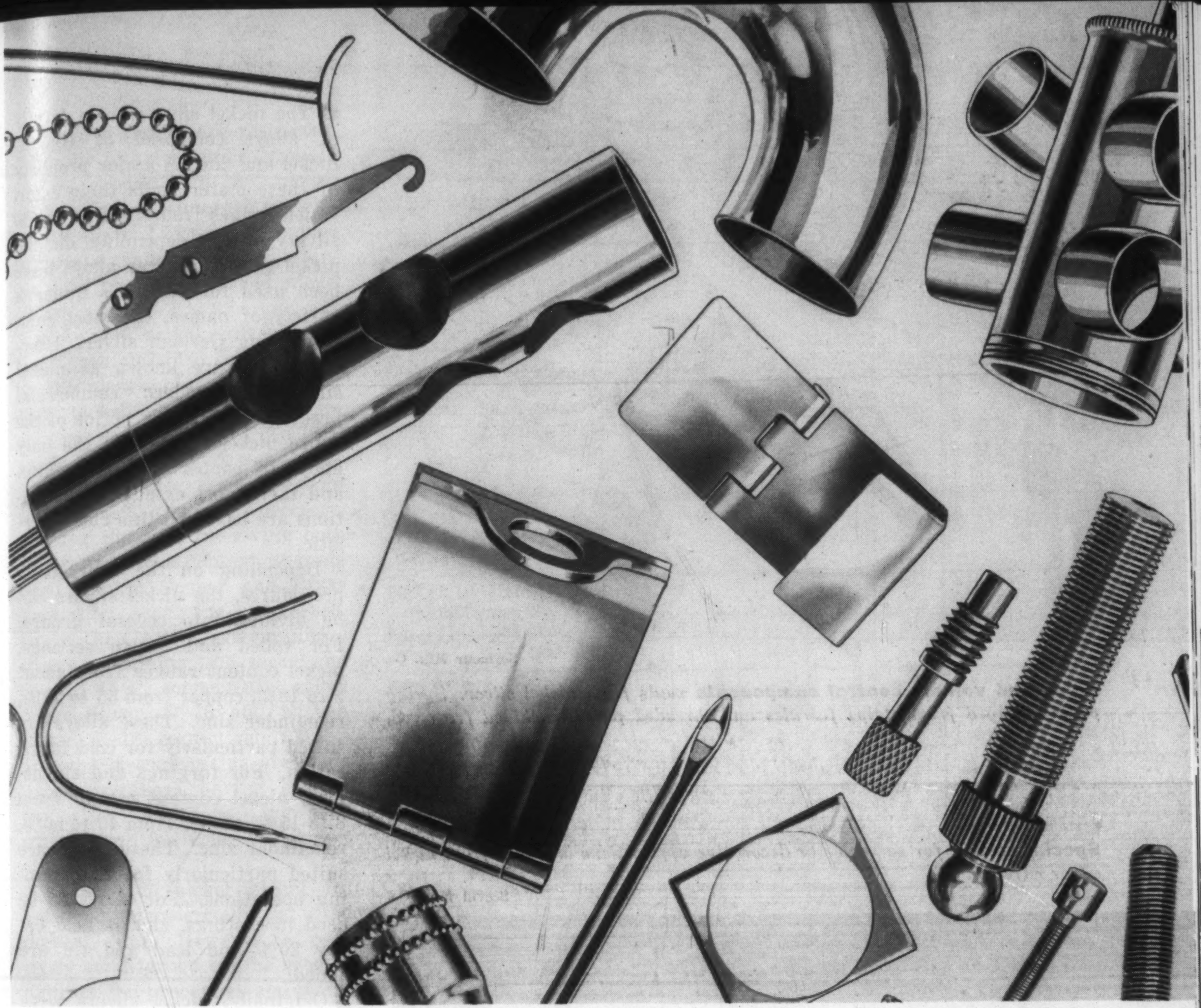
When awards will be made

The awards will be made during the week of the Design Engineering Show, May 20-23, 1957, in New York City. The exact time and place will be announced in an early issue of MATERIALS & METHODS.

Publication of entries

The award winning entries will be published in the May Design Engineering Show issue of MATERIALS & METHODS. Other entries not winning awards may be published at the discretion of the editors of MATERIALS & METHODS. Nonwinning entries that are published will be paid for at the usual rate.

This competition was first announced in the November, 1956 issue.



American Brass Co.

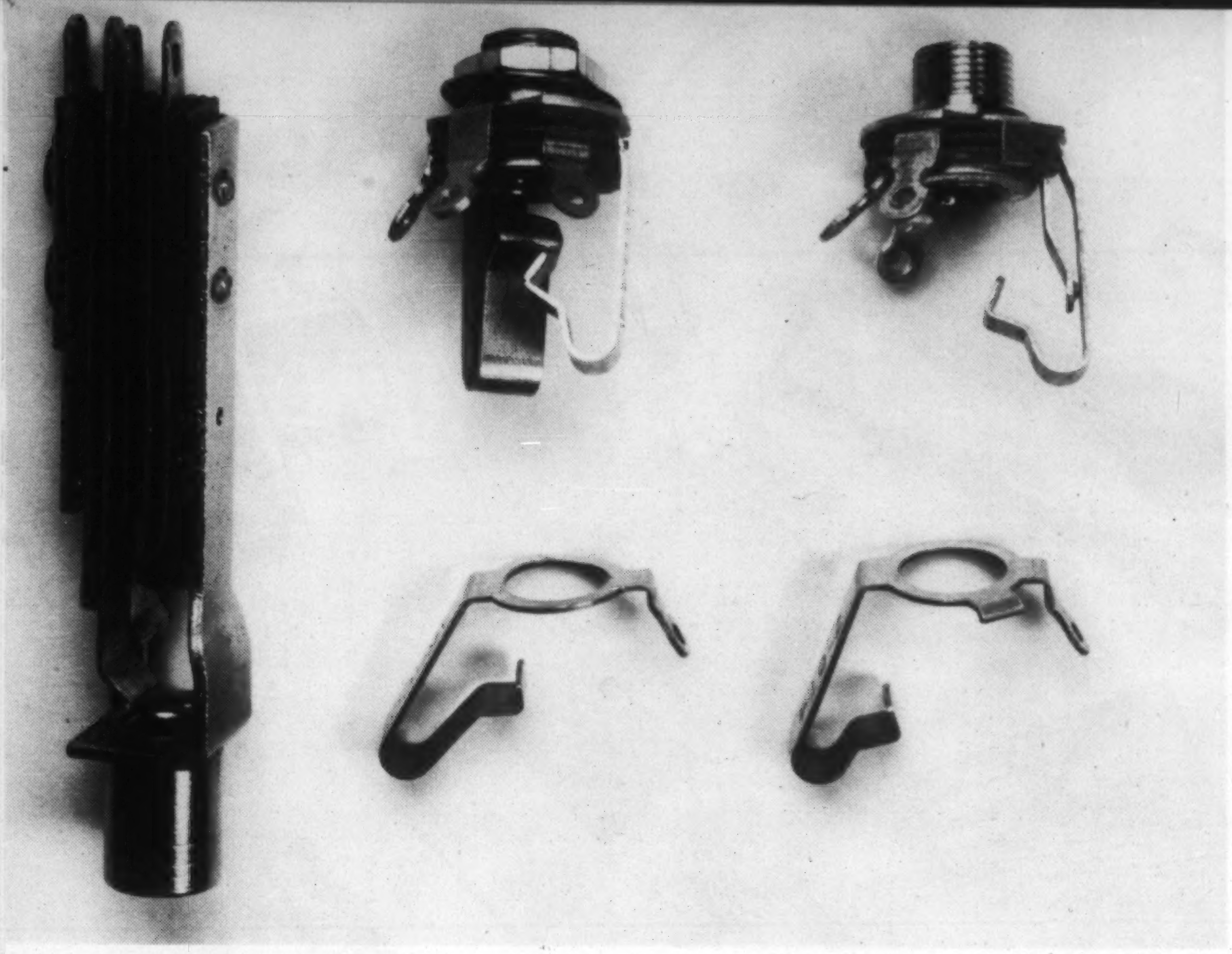
Nickel Silvers

by John L. Everhart,
Technical Editor,
Materials & Methods

The nickel silvers are a group of copper, nickel, zinc alloys which are employed for a variety of industrial and decorative applications because of their white color and excellent corrosion resistance. To assist in the selection of the proper grade for a specific application, this manual presents information on the following points:

- *Commercial grades*
- *Engineering properties*
- *Forming, machining*
- *Heat treating, joining*
- *Cleaning, finishing*
- *Applications*

MATERIALS & METHODS MANUAL NO. 133—DECEMBER 1956

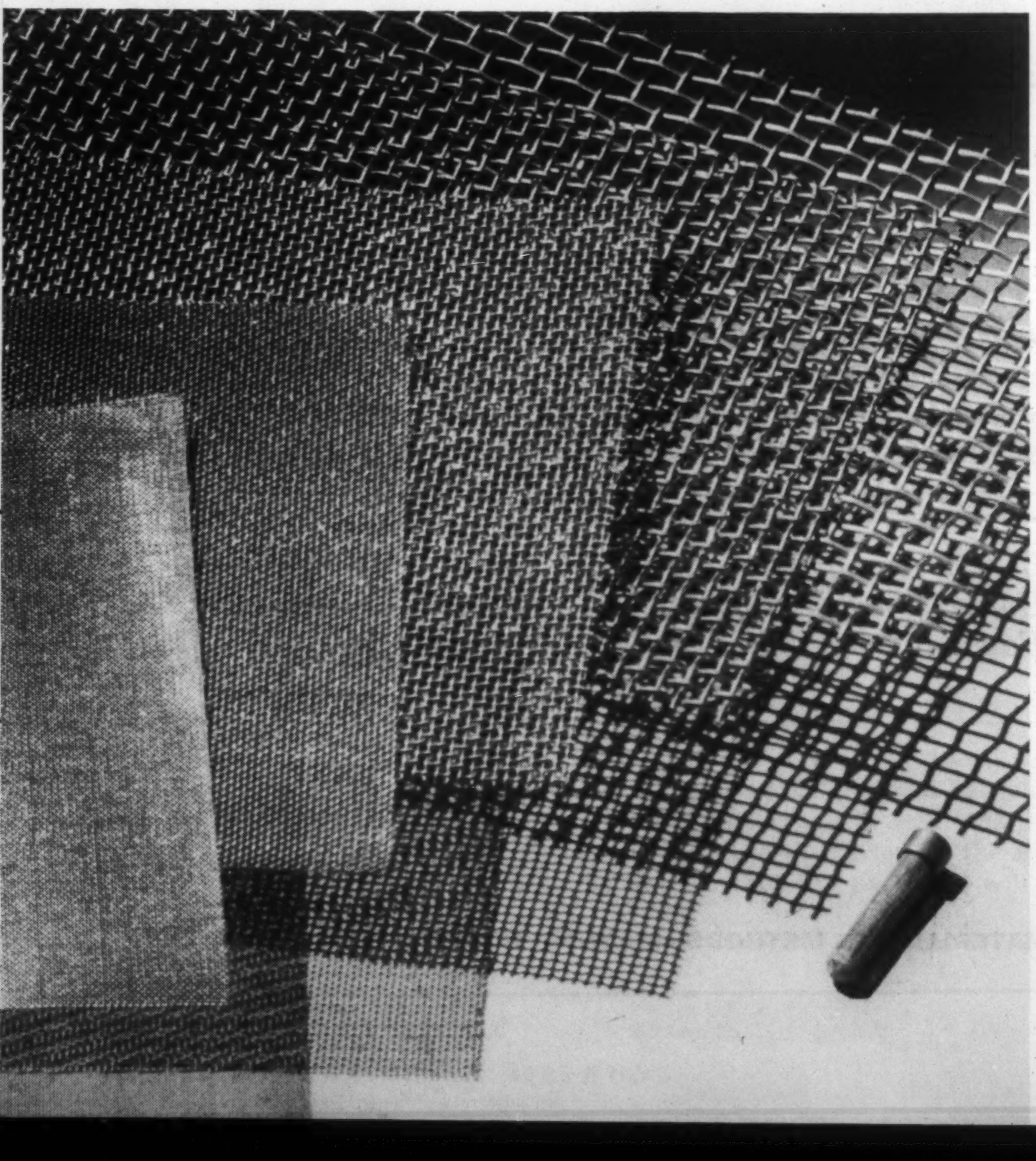


Seymour Mfg. Co.

Relay and volume control components *made from nickel silver. Spring parts stamped from strip; ferrules and threaded parts machined from rod.*

Special screen *for corrosive or decorative applications is woven from nickel silver wire.*

Scovill Mfg. Co.



■ The nickel silvers are a family of alloys composed of copper, nickel and zinc. A major property of these materials is their color, which ranges from a soft ivory to silvery white, depending on the nickel content. These alloys have been used for centuries under a variety of names, the most common being German silver. However, they are known as nickel silvers in modern commercial practice. With the exception of the cupro nickels, these are the only alloys of copper that are white, and their most extensive applications are based on this characteristic.

Depending on the fabricating procedures, the nickel silvers can be divided into several groups. For rolled and drawn sections, nickel content ranges from about 5 to 18%, copper from 55 to 72%, remainder zinc. These alloys are suited particularly for cold fabrication. For forgings and extrusions, nickel content ranges from 8 to 15%, copper from 40 to 50%, remainder zinc. These alloys are suited particularly for hot forming operations. For alloys to be used in castings, zinc is held below 20% and lead and tin are added.

Originally, nickel silvers were used most widely for decorative and architectural purposes. However, because of their excellent mechanical properties combined with resistance to corrosion in organic products, water and the atmosphere, nickel silvers have broadened in use to include food handling equipment and many hardware items where the white color makes it unnecessary to plate the surface to obtain a desired appearance.

This manual discusses the most widely used of the wrought and cast grades — their engineering properties, their fabricating characteristics and their applications.

Classification

Nickel silvers are essentially brasses in which part of the zinc has been replaced by nickel. Since a major reason for adding nickel is to obtain a white material, the composition limits of the usual commercial grades are restricted. Generally nickel silvers contain 45 to 72% copper, 5 to 18% nickel, balance zinc. To improve machinability, up to 2.75% lead is added to certain grades. Alloys containing lead are called leaded nickel silvers.

Although nickel silvers are sometimes classified commercially by the nickel content alone, e.g., 18% nickel silver, this practice does not define the alloy. An 18% grade containing 55% copper differs considerably from one containing 65% copper. Therefore, defining the alloy by giving both copper and nickel content, as practiced by the Copper and Brass Research Assn., is preferred. Under the CABRA system, nickel silvers containing 18% nickel and 55 or 65% copper are called Nickel-Silver, 55-18 and Nickel-Silver, 65-18, respectively. Modifications in composition are made to obtain alloys having specific properties such as improved spring qualities, color variations, etc.

At least 25 nickel silvers are available commercially at the present time. However, a relatively small group can be used to indicate the properties and working characteristics of all. Most of the alloys selected for discussion in this manual are covered by ASTM specifications. In general, the wrought alloys covered here are also Copper and Brass Research Assn. standard alloys, and the cast alloys have been recommended by the Brass and Bronze Ingot Institute. Compositions of the alloys are given above.

TABLE 1—NOMINAL COMPOSITIONS OF SOME NICKEL SILVERS

Commercial Designation	Composition, %					Nearest Applicable ASTM Specification
	Cu	Ni	Zn	Pb	Sn	
WROUGHT ALLOYS						
Nickel Silver 65–18	65	18	17	—	—	B 122–55T, No. 2 B 151–55, Alloy A B 206–54, Alloy A
65–15	65	15	20	—	—	—
65–12	65	12	23	—	—	B 151–55, Alloy D B 206–54, Alloy D
65–12, Leaded	65	12	21	2	—	—
65–10	65	10	25	—	—	B 151–55, Alloy E
55–18	55	18	27	—	—	B 122–55T, No. 4 B 151–55, Alloy B B 206–54, Alloy B
45–10	45	10	45	—	—	B 124–55, No. 14
Extruded Leaded Nickel Silver (46.5–10, Leaded)	46.5	10	40.75	2.75	—	—
POWDER METALLURGY PRODUCTS						
Nickel Silver 64–18	64	18	18	—	—	—
64–18, Leaded	64	18	16.5	1.5	—	—
CAST ALLOYS						
12% Leaded Nickel Brass (10A)	57	12	20	9	2	B 149–52, No. 10A
16% Leaded Nickel Brass (10B)	60	16	16	5	3	—
20% Leaded Nickel Bronze (11A)	64	20	8	4	4	B 149–52, No. 11A
25% Leaded Nickel Bronze (11B)	66.5	25	2	1.5	5	B 149–52, No. 11B

Note that in this table the cast alloys are called leaded nickel brass (10A and 10B) and leaded nickel bronze (11A and 11B). These are the names suggested in ASTM B 119-45 for cast nickel silver alloys.

Engineering Properties

Physical properties

Some of the physical properties of the nickel silvers are given in Table 2. Taking as an example the group of alloys containing 65% copper, the temperature at which melting starts decreases with decreasing nickel content (i.e., increasing zinc). Since this group of alloys comprises modifications of yellow brass, a comparison with the latter is interesting. Yellow brass starts to melt at about 1660 F, and Table 2 shows that the substitution of nickel for zinc raises the melting point by 150 to 300 F.

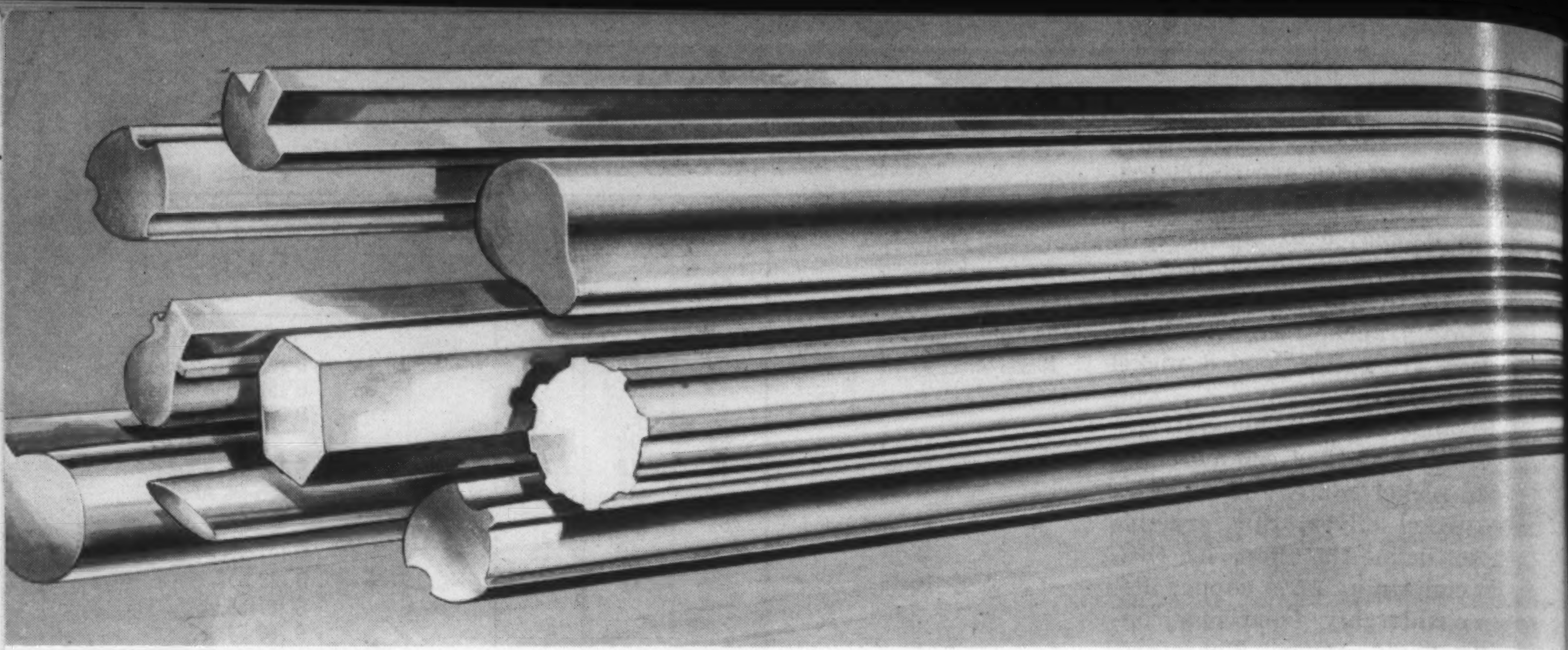
Substitution of nickel for zinc also affects other physical properties. In general, density and modulus of elasticity increase. Thermal and electrical conductivities are reduced sharply in comparison with yellow brass. Thermal conductivity of yellow brass is 67 Btu/sq ft/ft/hr/F whereas the nickel silvers under discussion have thermal conductivities ranging from 14 to 26. Electrical conductivity of yellow brass is 27% IACS; for the nickel silvers it ranges from 4.5 to 10%.

Color, a major property of these alloys, also varies with nickel content. An accompanying graph indicates the variation in color obtainable. For example, 65-18 is silver-blue-white, but 65-12 is yellow-white.

Mechanical properties

The nickel silvers can be hardened only by cold working, and the mechanical properties of the wrought alloys are determined by the degree of annealing or by the cold working performed after annealing. In the brass industry, the condition of the alloy resulting from annealing or cold working is called "temper."

The degree of anneal in single



American Brass Co.

Extruded shapes *of various contours are produced from leaded nickel silver.*

phase alloys is indicated by the grain size. The nominal annealed tempers commonly specified for nickel silvers are 0.015 mm, 0.025 mm, 0.035 mm, 0.050 mm and 0.070 mm. Generally, the larger the grain, the softer the material.

For example, tensile strength of 65-15 annealed to 0.070 mm grain size is 53,000 psi and hardness is Rockwell B 22. The same material annealed to 0.015 mm grain size has a tensile strength of 61,000 psi and a hardness of Rockwell B 55. Ductility is also affected. At 0.070 mm grain size elongation is 43%, and at 0.015 mm it is only 34%.

Tempers of cold worked copper alloys are generally specified by such terms as half hard, hard, etc. To the brass industry, these terms denote certain reductions in thickness for flat products and certain reductions in area for wire. For flat products, for example, half hard indicates a thickness reduction of approximately 21% and hard indicates a reduction of about 37%.

Typical mechanical properties of representative wrought nickel silvers are given in Table 3. In general, values of annealed flat products are shown as ranges to indicate the variation that can be expected when the material is annealed to different grain sizes. As indicated above, the higher values of strength and hardness and the lower values of elongation apply to the finer grain material.

The effects of cold working are also shown in this table. Strengths increase with the degree of cold working, and there is a corresponding decrease in ductility. Note that shear strengths of the wrought nickel silvers are about 70% of tensile strength for annealed material and about 60% for worked material.

Endurance properties of two grades of wrought nickel silver are given in Table 4. The endurance ratio ranges from 0.22 for spring grade 55-18 to 0.25 for annealed material of the same grade. A ratio of 0.35 has been reported for cold drawn 65-18. As a rough approximation, endurance strengths of the nickel silvers in both annealed and cold

TABLE 2—TYPICAL PHYSICAL PROPERTIES

Designation[a]	Melting Range		Density, lb/cu in.[b]	Coef of Ther Exp/°F (68–572 F)	Ther Cond, Btu/sq ft/ft/hr/°F[b]	Elec Cond % IACS[b]	Spec Ht, Btu/lb/°F[b]	Mod of Elast, psi	Mod of Rigidity, psi
	Liquids, F	Solids, F							
Wrought Alloys									
65–18	2030	1960	0.316	9.0×10^{-6}	19	6	0.09	18×10^6	6.8×10^6
65–15	1970	1900	0.314	9.0×10^{-6}	21	7	0.09	18×10^6	6.8×10^6
65–12	1900	1830	0.314	9.0×10^{-6}	23	8	0.09	18×10^6	6.8×10^6
65–12, Leaded	1900	1830	0.314	9.0×10^{-6}	22	7.5	0.09	17×10^6	—
65–10	1870	1800	0.313	9.1×10^{-6}	26	9	0.09	17.5×10^6	6.5×10^6
55–18	1930	1830	0.314	9.3×10^{-6}	17	5.5	0.09	18×10^6	6.8×10^6
45–10	1715	—	0.306	9.0×10^{-6}	27	10	—	—	—
46.5–10, Leaded	1715	—	0.306	—	—	8.5	—	—	—
Cast Alloys									
10A	—	—	0.32	—	16	6	—	16×10^6	—
10B	—	—	0.32	—	16	5.5	—	—	—
11A	—	—	0.32	—	14	5	—	17.5×10^6	—
11B	—	—	0.32	—	15	4.5	—	20×10^6	—

[a] See Table 1 for composition.

[b] At 68 F.

worked conditions can be taken as 20 to 30% of the tensile strength.

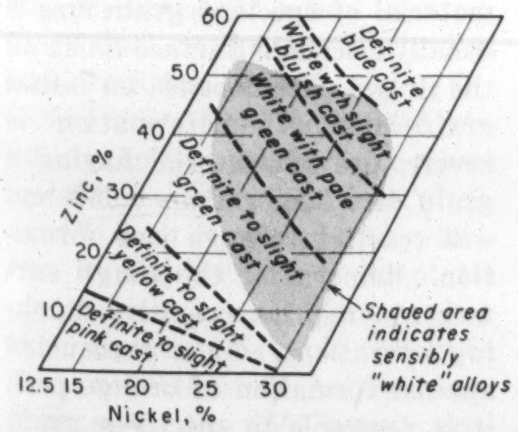
Tensile properties of two types of nickel silver metal powder compacts are included in Table 3. Tensile strength and elongation of 64-18 produced from powder are higher than those obtained on brass powder compacts in general, although certain brass powder mixes containing phosphorous have higher ductility.

Properties that can be expected of standard casting alloys when they are cast in sand molds are given in Table 3. Ranges are given to indicate the effect on properties of such factors as section size. In general, strengths and ductilities are comparable with those of sand cast leaded yellow brass.

Temperature properties

In common with other copper alloys, nickel silvers retain their ductility at low temperatures. As the temperature falls, strength and stiffness increase. There is no indication of a transformation from ductile to brittle behavior, and the nickel silvers can be used satisfactorily at temperatures at least as low as −300 F. Low temperature mechanical properties of a 55-30 nickel silver alloy are given in Table 5.

Most copper alloys soften in the range 400 to 800 F, depending on the amount of cold work and the type of alloy. Thus there is a definite limitation on their suitability for elevated temperature service. There is little specific in-



Color *of the nickel silvers is determined by the nickel content.*

(Kihlgren, Pilling and Wise)

TABLE 3—TYPICAL MECHANICAL PROPERTIES

Designation[a]	Form and Condition	Yld Str (0.5% ext under load), 1000 psi	Ten Str, 1000 psi	Elong (2 in.), %	Rockwell Hardness	Shear Str, 1000 psi
WROUGHT ALLOYS						
65–18	Flat products:					
	Annealed[b]	25–30	58–60	32–40	B40–55	—
	Half Hard	62	74	8	B83	—
	Hard	74	85	3	B87	—
	Rod:					
	Annealed	25	56	42	—	—
	Half Hard (20%)	60	70	20	B78	—
	Wire:					
	Annealed[a]	25–30	58–60	45–35	—	—
	Half Hard	80	86	7	—	—
	Hard	90	103	3	—	—
65–15	Flat products:					
	Annealed[b]	18–28	53–61	34–43	B22–55	41
	Half Hard	62	74	10	B80	47
	Hard	75	85	3	B87	52
	Extra Hard	79	92	2	B90	54
65–12	Flat products:					
	Annealed[b]	18–28	52–61	35–48	B22–55	41
	Half Hard	60	73	11	B80	47
	Hard	75	85	4	B89	52
	Extra Hard	79	93	2	B92	56
65–12, Leaded	Flat products:					
	Annealed[b]	18	52	40	B27	—
	Hard	79	89	3	B86	—
	Rod:					
	Annealed	24	55	40	—	—
	Hard	60	70	18	B80	—
65–10	Flat products:					
	Annealed[b]	18–28	49–60	36–49	B22–52	41
	Half Hard	60	73	12	B80	50
	Hard	75	86	4	B89	55
	Extra Hard	76	95	3	B92	59
	Wire:					
	Annealed[b]	—	50–63	35–50	—	—
	Half Hard (37%)	—	85	7	—	—
	Hard (60%)	—	105	5	—	—
	Spring (84%)	—	130	1	—	—
55–18	Flat products:					
	Annealed (0.035 mm)	27	60	40	B55	—
	Hard	85	100	3	B91	—
	Extra Hard	90	108	2.5	B96	—
	Spring	—	115	2.5	B99	—
	Wire:					
	Annealed (0.035 mm)	—	60	40	—	—
	Spring (68%)	—	145	2	—	—
45–10	Forged	36	83	25	B73	48
46.5–10, Leaded	Extruded	50–60	75–88	30–35	B80–84	—
POWDER METALLURGY PRODUCTS						
64–18	Sintered at 1795 F[d]	—	32	15	H80	—
64–18, Leaded	Sintered at 1615 F[d]	—	28	10	H78	—
CAST ALLOYS						
10A	Sand cast	15–20	30–40	10–25	50–60[c]	—
10B	Sand cast	17–24	35–45	15–30	65–80[c]	—
11A	Sand cast	17–30	40–60	15–25	76–120[c]	—
11B	Sand cast	26–40	50–65	15–25	120–150[c]	—

[a] See Table 1 for composition.

[b] Properties of annealed material vary with grain size (see text).

[c] Brinell hardness.

[d] Compacted at 31-2 psi to density of 7.5-7.8.

TABLE 4—FATIGUE PROPERTIES

Material	Condition	Tensile Strength, psi	Fatigue Strength, (10^8 cycles), psi	Endurance Ratio
65-18 Rod[a]	Cold drawn	62,500	22,000[c]	0.35
55-18 Strip[b]	Annealed	66,000	16,500	0.25
	Half hard	83,700	25,000	0.30
	Hard	97,600	20,800	0.22
	Extra hard	105,300	23,400	0.22
	Spring	112,300	24,700	0.22
	Extra spring	115,500	23,250	0.20

[a]Source: *McAdam.* [b]Source: *Gohn, Guerard and Herbert.* [c]Based on 5×10^7 cycles.

formation on the effect of temperature on the nickel silvers, but there is no doubt that their high temperature properties are at least as good as those of the brasses. The data given in Table 6 indicate that these alloys lose most of their ductility in the range 500 to 600 F, although short time strength in the same temperature range does not show so sharp a drop.

Corrosion resistance

Nickel silvers, like other copper alloys, are attacked rapidly by oxidizing acids. The rate of attack by other acids depends on the presence or absence of an oxidizing agent. The alloys are resistant to sodium and potassium hydroxides but are attacked rapidly by ammonium hydroxide and moist ammonia.

Neutral salts can be handled in nickel silver equipment, but salts that hydrolyze to form acids, particularly those having oxidizing properties, are strongly corrosive. Mercury and mercury salts cannot be handled by copper alloys. (In fact, because of its rapid attack, mercurous nitrate is used in an accelerated test to determine the presence of internal stress in copper alloys.)

The nickel silvers have good resistance to rural and marine atmospheres and to fresh and salt waters. Nickel silvers generally have greater resistance to salt solutions than brasses of the same zinc content.

Like other copper alloys, the nickel silvers are subject to stress corrosion resulting from the combined action of localized stresses and corrosion. The stress can result from cold deformation or can exist because of an external load. Presence of moist ammonia in the atmosphere is considered to be the major cause of stress corrosion cracking. Internal stresses can be removed by a stress relieving heat treatment.

There are so many factors involved in the selection of a material for service under corrosive conditions that the only satisfactory procedure is a service test. However, some idea of the resistance of nickel silvers to various corrosive environments can be obtained from Table 7. This table should be used only for preliminary screening.

Processing Characteristics

The fabricating properties of the nickel silvers are summarized in Table 8. Wrought nickel silvers can be divided into two classes: cold working and hot working materials. The former class consists of structurally single-phase materials and includes all of the wrought alloys listed except 45-10 and 46.5-10, leaded. These two alloys have duplex structures. They have poor cold working properties but excellent hot workability.

Cold working

The single phase alloys are malleable and quite ductile; some can be cold worked more readily than yellow brass. Of the nickel silvers mentioned, 65-18 and 65-15 have the best ductility, 65-12 and 65-10 are next, and 55-18 has the lowest ductility. Severity of the forming operation may dictate the composition selected. Thus 65-18 can be used for severe deep drawing, whereas 55-18 is not suitable.

Shearing — Clearance required in blanking depends on the thickness and temper of the metal. Generally a clearance of about 5% is sufficient to produce blanks free from burrs. Elimination of burrs is particularly important if the blank is to be used for deep drawing.

Bending, forming — Minimum bend radius depends on the alloy, its temper and the bend direction. Because of its directional properties, material in the cold worked condition can be bent more readily across the rolling direction than parallel to it. In general, nonleaded nickel silvers 0.020 in. thick can be bent 90 deg in any direction in the half hard condition. Suggested bend radii for 55-18 nickel silver are given in Table 9. These radii can also be used for the other nonleaded grades.

Drawing—Deep drawing operations can be performed on all of the 65% copper nonleaded nickel silvers. Grain size is important in deep drawing, and annealed material of specified grain size is usually selected. Surface finish on the drawn part depends on initial grain size. If deformation is severe, use of material having a grain size larger than 0.050 mm will result in orange peel formation. Removal of the rough surface can require extensive finishing operations. As a precaution against formation of orange peel, it is desirable to specify a grain size less than 0.035 mm for sheet up to 0.050 in. thick.

In forming a cup, a sheet metal

blank is forced into a die by a punch. During the operation, blank diameter is reduced and the metal in the flange is thickened and subsequently reduced in thickness as it passes between punch and die. The degree of reduction in diameter that can be performed successfully depends on alloy composition and temper, blank diameter, tool radii and lubrication, among other factors. Tooling that is satisfactory for deep drawing yellow brass can also be used for nickel silver.

Redrawing is necessary when a greater depth of cup is required than can be produced in a single stage. It is essential to perform redrawing in a succession of decreasing reductions to divide the work between reduction in diameter and reduction in thickness. Allowable reduction between anneals varies with the metal, but generally an anneal is required after the total reduction following the previous anneal reaches 50 to 60%. Reductions frequently used in single action redrawing are 30, 25, 16, 13 and 10%. These reductions are not additive but instead indicate the change in dimensions in the one stage concerned. Thus the 25% reduction mentioned is a reduction of 25% of the depth of the cup after the first draw. These suggested reductions apply only to round shells; for complex shapes, the permissible reductions are much smaller.

Ironing reduces shell walls by pulling them through tight dies. The operation is used to produce uniform wall thickness or to obtain a tapered wall. If the material is annealed before ironing, theoretical maximum reduction in wall thickness is 50%.

Spinning—This method of producing hollow shapes from sheet metal disks is an important alternate to deep drawing because tooling is cheaper. It is adaptable particularly to short run production. Spinning is used widely in the production of hollow ware from all of the 65% copper nonleaded compositions. Generally, an annealed temper with grain size ranging from 0.015 to 0.035

TABLE 5—LOW TEMPERATURE PROPERTIES
(55 Cu, 30 Ni, 14 Zn)

Property	Temperature, F				
	Room	−40	−80	−180	−290
Ten Str, psi	75,300	78,200	83,100	89,800	104,000
Yld Pt, psi	22,900	28,600	27,500	28,800	28,400
Elong, %	33	34	39	38	41
Red of Area, %	53	52	52	52	55
Izod Impact Str, ft-lb	80	87	83	80	79

Source: *Smith.*

TABLE 6—ELEVATED TEMPERATURE PROPERTIES

Material	Test Temp, F	Ten Str, psi	Elong (2 in.), %	Red of Area, %
74 Cu, 20 Ni, 5 Zn—Cold Drawn, ann at 1200 F[b]	85	50,400	51.0	75
	600[a]	45,000	28.5	72
66 Cu, 10 Ni, 24 Zn—Wrought[c]	80	61,800	14.0	34.8
	350	61,200	16.5	28.6
	550	58,200	10.5	17.0
	650	47,100	1.0	5.3
	750	48,700	2.0	6.3
	900	42,400	3.5	5.9
46 Cu, 13 Ni, 39 Zn—Cast[c]	80	71,500	26.5	25.3
	500	55,800	8.6	11.0
	550	60,000	4.5	6.0
	600	48,200	0.4	0.4

[a] Stress for 0.01% creep in 1000 hr is 13,800 psi; stress for 0.1% creep in 1000 hr is 27,800 psi.
[b] Source: *ASTM-ASME Compilation on Creep.*
[c] Source: *ASTM STP 181.*

TABLE 7—APPROXIMATE CORROSION RESISTANCE OF NICKEL SILVERS[a]

Good	Fair	Poor
Ammonia, dry	Acetic acid	Ammonia, moist
Atmosphere, industrial, marine or rural	Bleachingpowder, wet	Ammonium hydroxide
Brines	Calcium bisulfite	Ammonium chloride
Calcium chloride	Carbon dioxide, moist	Chromic acid
Carbon dioxide, dry	Chlorine, moist	Ferric chloride
Chlorine, dry	Ferrous chloride	Hydrocyanic acid
Citric acid	Formic acid	Mercury salts
Hydrogen sulfide, dry	Hydrochloric acid	Nitric acid
Potassium chloride	Hydrogen sulfide, moist	Potassium cyanide
Potassium hydroxide	Oxalic acid	Silver salts
Sodium bisulfate	Phosphoric acid	Sodium cyanide
Sodium chloride	Sodium hypochlorite	Sodium dichromate, acid
Sodium chromate	Sodium sulfide	Sulfur, molten
Sodium hydroxide	Stearic acid	
Sulfur dioxide, dry	Sulfur, dry	
Water, sea or potable	Sulfur dioxide, moist	
	Sulfuric acid	
	Zinc chloride	
	Zinc sulfate	

[a] *Good*—usable under most conditions. *Fair*—subject to attack but may be used under certain conditions. *Poor*—unsuitable.

mm is used in spinning.

An indication of the relative ease of spinning can be obtained by comparison with copper, which is the easiest material of the copper group to spin cold. It has been suggested that, if an arbitrary value of 100 be assigned to copper, nickel silver 65-18 has a rating of 95 for shallow spinning and 65 for deep spinning. On the same basis, yellow brass rates 99 for shallow spinning and 92 for deep spinning.

Expanding, contracting—Nickel silvers are often used in the production of hollow tableware. Thus, it is frequently necessary to perform expanding or contracting operations such as bulging or necking.

Bulging reduces metal thickness in proportion to the total stretching given the part. Maximum bulging can be performed on annealed material; increases in diameter of 15 to 30% can be obtained in a single operation.

Necking involves severe cold working and the reduction which can be achieved in a single operation is quite limited. Maximum reduction depends on the hardness of the drawn part and the

TABLE 8—FABRICATING PROPERTIES

Material	Cold Work-ability	Hot Work-ability	Hot Working Temp Range, F	Annealing Temp Range, F	Casting Temp Range, F	Machine-ability Rating[a]
Wrought Alloys						
65-18	Excellent	Poor	—	1100–1500	—	20
65-15	Excellent	Poor	—	1100–1500	—	20
65-12	Excellent	Poor	—	1100–1500	—	20
65-12, Leaded	Good	Poor	—	1100–1500	—	60
65-10	Excellent	Poor	—	1100–1400	—	20
55-18	Good	Poor	—	1100–1500	—	30
45-10	Poor	Excellent	1100–1550	—	—	40
45-10, Leaded	Poor	Excellent	1350–1550	—	—	80
Cast Alloys						
10A	—	—	—	—	2000–2400	70
10B	—	—	—	—	2050–2450	70
11A	—	—	—	—	2250–2600	60
11B	—	—	—	—	2300–2600	60

[a] Free cutting brass=100.

TABLE 9—MINIMUM BENDING RADII
(55-18 Strip)

Temper	Nominal Thickness, in.	Minimum Bending Radius, in.	
		Across Grain	With Grain
Half Hard	0.020	Can bend sharp	Can bend sharp
Hard	0.020	1/32	1/32
Extra Hard	0.020	3/64	1/8
	0.040	1/8	3/16
	0.080	1/4	3/8

Source: *Gohn.*

TABLE 10—SUGGESTIONS FOR MACHINING[a]

Operation	Surface Speed, ft/min		Feed, in./rev		Tool Angle, deg	
	Nonleaded Nickel Silvers	Leaded Nickel Silvers	Nonleaded Nickel Silvers	Leaded Nickel Silvers	Nonleaded Nickel Silvers	Leaded Nickel Silvers
Turning	75–150	150–300	Roughing 0.015–0.040 Finishing 0.005–0.020	Roughing 0.015–0.035 Finishing 0.005–0.015	Side rake 20–30 Back rake 10–20 Side clearance 10–20 Front clearance 10–15 Lead angle 15	Side rake 5–10 Back rake 5–10 Side clearance 5–10 Front clearance 6–15 Lead angle 10–15
Parting	75–150	150–300	0.005	0.0015	End cutting edge 25 Back rake 7–15 Side clearance 2–4 Front clearance 5–10	End cutting edge 15 Back rake 3–7 Side clearance 2–4 Front clearance 5–10
Milling	50–150	150–200	b	b	Rake 0–15 Clearance 5–10	Rake 0–10 Clearance 6–12
Drilling	50–125	75–250	0.003–0.020	0.003–0.020	Clearance 12–20 Drill point 100–110 Cutting edge full rake (do not flatten)	Clearance 12–15 Drill point 118 Cutting edge 0–rake (flatten approx 6–8% of dia)

[a] Using high speed steel tools.

[b] Varies with such factors as: cutter width; feed rate, which also may vary; desired finish.

composition of the alloy, but is limited to about 8 to 17% of original diameter.

Squeezing — Squeezing operations, which include coining, embossing and stamping, are the most severe used in fabricating sheet and strip. To prevent distortion, quarter hard or half hard nickel silvers are used in these operations.

Upsetting—Operations of this type are performed on rod or wire to produce heads on screws, rivets and bolts. Lightly cold worked material is used to resist bending during formation of the head.

Hot forming

The 45-10 alloy has excellent hot forming properties over a wide temperature range. Forging and hot pressing practice is the same as that used for brass. (The term forging as applied to the brass industry generally refers to hot press-forging in closed dies. Drop forging finds only limited application.)

An indication of the relative ease of hot working nickel silver 45-10 is obtained by comparison with the brasses. If forging brass is given a rating of 100, Muntz metal rates 90 and nickel silver 45-10 rates 85.

The 45-10 alloy can be hot formed also by bending, flaring, dishing and spinning. Hot extrusion is used on both 46.5-10, leaded, and 45-10 nickel silvers for the production of various architectural and semifinished shapes.

Powder metallurgy

Various small nickel silver parts are produced by powder metallurgy. The most widely used composition is 64-18, but other grades are available.

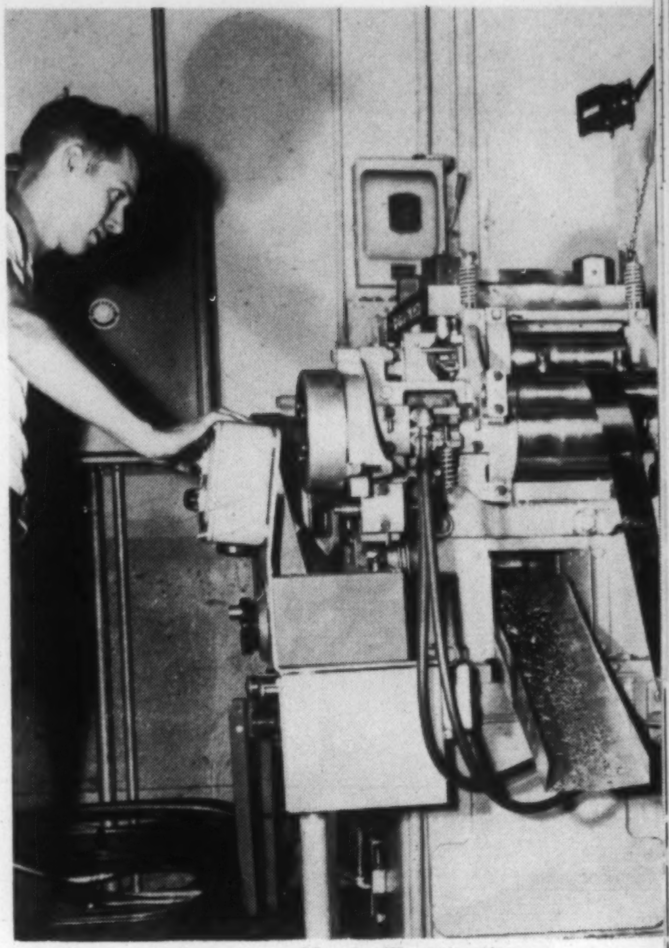
Powder of the selected composition is compressed in a die to form a compact which is subsequently sintered by heating at a temperature sufficiently high to yield the desired properties. Optimum sintering temperature for the 64-18 composition is 1795 F. Depending on the accuracy required, compacts may or may not be coined or sized after sintering.

The process is applicable particularly to long run production at high speed. Single punch presses commonly produce 500 to 1000 parts per hr and higher rates are reached on some designs. Multiple punch presses can produce 6000 or more parts per hr. Sizing can be done at comparable speeds.

Casting

The wrought nickel silvers are alloys of copper, nickel and zinc. To produce suitable casting alloys, however, the compositions are usually modified by the addition of tin and lead. Tin contributes strength and hardness, lowers the melting point of the alloy, and improves casting quality by moderately increasing fluidity. Lead lowers the strength and ductility somewhat, but appears to improve the pressure tightness in castings to be used in hydraulic applications. Probably the major contribution of lead is improved machinability.

Sand casting is the most eco-



North Electric Co.

Blanking *relay contact springs from nickel silver.*

North Electric Co.

Relay contact spring *seated in welder for installation of contact point.*

North Electric Co.

Adjusting and inspecting *relay after assembly.*

nomical casting method and offers the greatest flexibility in size and shape. The nickel silvers can also be permanent mold cast, centrifugally cast, investment cast and plaster mold cast successfully.

Generally, the nickel silvers are classed as high shrinkage alloys. Careful design is necessary to eliminate abrupt changes in the cross section of the casting, to provide liberal fillets, and to position gates and risers properly to avoid internal shrinkage. Since the nickel silvers are sensitive to reducing gases, rapid melting, proper deoxidation (with magnesium, lithium, phosphorus-copper, etc.) and rapid pouring without excessive turbulence are necessary. Suggested casting temperatures are given in Table 8.

The relative ease of producing nickel silver sand castings has been expressed as follows: If high leaded tin bronze is rated 1 (best) for castability, leaded yellow brass rates 4, nickel silvers 11A and 11B rate 5. If silicon brass is rated 1 for fluidity, leaded yellow brass is 4 and the two nickel silvers are 7. From a cost standpoint, with 85-5-5-5 leaded red brass rated as 100, leaded yellow brass is 85, nickel silver 11A is 112, and nickel silver 11B is 118.

In plaster mold casting, tolerances of ± 0.005 in. per in. can be held where dimensions do not cross parting lines. Nickel silver castings reproduce the surface smoothness of the mold and little polishing is necessary to finish the casting.

Nickel silver 45-10 is a two-phase alloy which is hot workable. It can be die cast and parts produced by this method have surfaces that need little polishing or buffing.

Machinability

The nonleaded nickel silvers are less readily machinable than brasses of the same zinc content and this fact must be considered in selecting tool design, speed, feed and depth of cut for satisfactory metal removal. Generally, it is good practice to use the highest practical cutting speed, a relatively light feed and a moderate depth of cut for the wrought alloys. In the machining of sand castings, however, cutting at low speeds with a coarse feed to remove the surface increases the life of high speed tools. After removal of the surface, higher speeds and lighter feeds can be used. If carbide tools are used on sand castings, the practice suggested for wrought alloys can usually be employed.

The relative machinability of copper alloys is indicated by comparing them with free-cutting brass. This alloy is a leaded version of yellow brass containing 62 copper, 3 lead and 35% zinc. It is the most readily machinable of the copper alloys and given an arbitrary rating of 100, serves as a standard of comparison for the machinability of nonferrous alloys in general.

Based on this standard, the nonleaded nickel sivers 65-18, 65-15, 65-12 and 65-10 have a machinability rating of 20 and are classified as difficult to machine. Nickel silver 45-10 and the leaded alloys are rated from 40 to 80 and are considered readily machinable.

In turning the nonleaded nickel silvers, relatively large rake angles are required. Side rakes may exceed those used for steel.

TABLE 11—SUITABILITY OF JOINING METHODS

Nickel Silver Type	Soldering	Silver Alloy Brazing	Carbon Arc Welding	Resistance Welding	Oxy-acetylene Welding
65-18	Excellent	Excellent	Fair	Excellent	Good
65-15	Excellent	Excellent	Fair	Excellent	Good
65-12	Excellent	Excellent	Fair	Excellent	Good
65-12, Leaded	Excellent	Good	Fair	Fair	Fair
65-10	Excellent	Excellent	Fair	Excellent	Good
55-18	Excellent	Excellent	Poor	Excellent	Good
45-10	Excellent	Good	Good	Good	Good
46.5-10, Leaded	Excellent	Good	Fair	Fair	Fair

These alloys usually produce long, springy turnings. For the leaded alloys, considerably lower rake angles are satisfactory. Suggested tool angles are given in Table 10. The leaded alloys can be machined at speeds considerably higher than those used for the nonleaded materials.

Most of the commercial milling cutters and standard high speed steel cut-off tools are suitable for machining the nickel silvers. A clearance angle of 5 to 10 deg has been used successfully for milling nonleaded nickel silvers.

Standard carbon or high speed steel drills are satisfactory for drilling the nickel silvers if production volume is small. As shown in Table 10, the cutting edge should be flattened for cutting the leaded alloys, but should not be flattened for use on the nonleaded materials. For long run operations, specially designed drills having a greater number of twists per inch than the standard drills are often used.

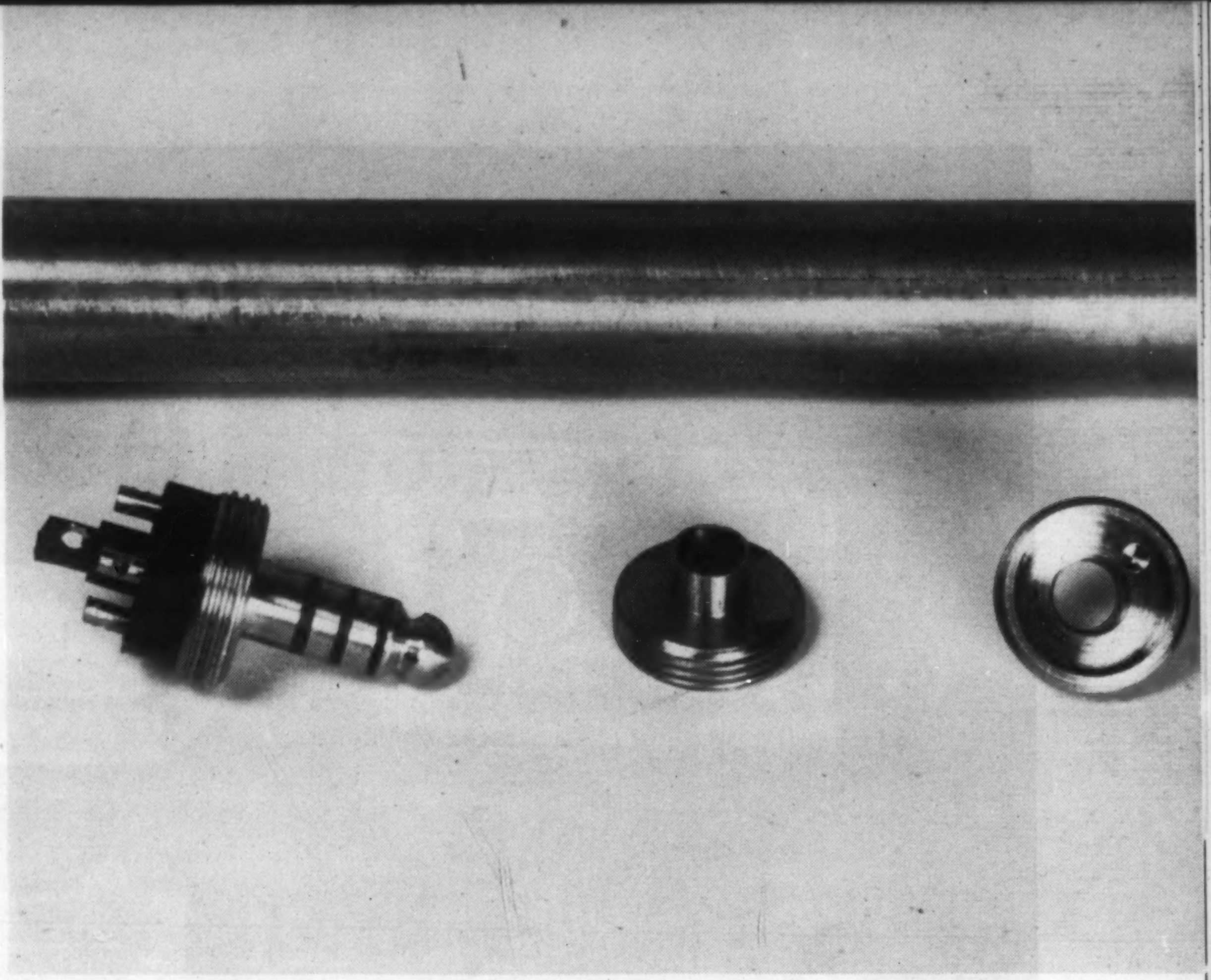
Use of a coolant is generally required to obtain fine surfaces at high cutting rates. Although turning and drilling are sometimes performed dry in small quantity production, coolants should always be used on operations involving taps, dies, reamers, form tools and cut-off tools. Suitable coolants for the nonleaded nickel silvers are sulfur-free soluble oils in dilute water mixtures or mineral-lard oil compounds. Sulfurized coolants discolor nickel silvers and should be avoided.

Heat treatment

Nickel silvers cannot be hardened by heat treatment. However, heat treatments are used to soften the metal for additional working or to relieve stresses.

Annealing consists of heating the alloy to, or above, the recrystallization temperature and holding for sufficient time to obtain complete recrystallization. Annealing temperature ranges are given in Table 8.

After recrystallization is complete, grain growth occurs if heating time is prolonged. If large

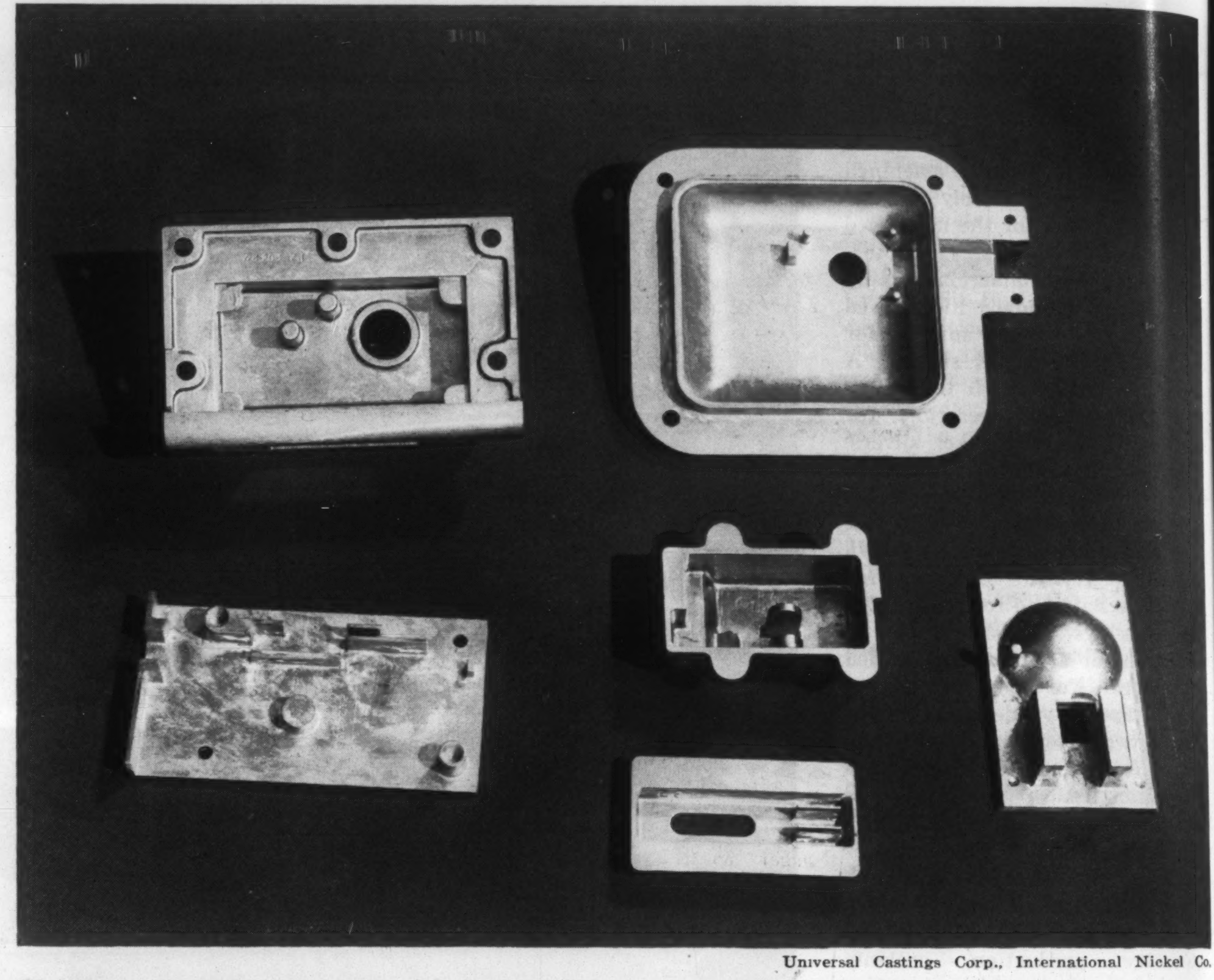


Seymour Mfg. Co.

Electrical contact jack *parts machined from nickel silver rod.*

Copper & Brass Research Assn.

Millions of keys *are produced from leaded nickel silver because of its ability to resist corrosive attack, wear and high torsional strains.*



Universal Castings Corp., International Nickel Co.

Car lock cases, parts and latches *of cast nickel silver are used in railroad Pullman and dining cars.*

grains are required, a more effective method of increasing grain size is to raise the temperature. The grain size resulting from annealing is also affected by the prior working the metal has received. Increasing the degree of cold work lowers the recrystallization temperature. However, the smaller the amount of prior deformation, the larger the average annealed grain size.

Size of the grain after annealing is the most accurate method of determining the degree of annealing, and in the brass industry annealed tempers are specified by grain size. Mechanical properties vary with grain size; as grain size increases, strength and hardness decrease and ductility increases.

A stress relief heat treatment is used also to prevent stress corrosion cracking resulting from residual stresses induced by cold working. Stress relief heat treatments are conducted at relatively low temperatures. Preferred practice is to use the lowest temperature for the longest time that is commercially practical. For the nickel silvers, temperatures of about 450 to 600 F are satisfactory. There is no recrystallization of the metal and consequently no softening. Tensile strength and hardness are practically unchanged by stress relieving.

Joining

The nickel silvers can be joined by soldering, brazing and various welding processes. Relative ease of joining by these methods is indicated in Table 11. Adhesive bonding is also used.

Soldering — The nickel silvers can be soldered easily using any of the standard methods. Because of the low temperatures employed, cold worked material usually retains its hardness during a soldering operation, an advantage over brazing and welding. Standard 50 tin-50% lead solder is used for most soldering operations, but 60 tin-40% lead is more satisfactory for joining thin sheet. Acid fluxes of the zinc chloride type are easiest to use. These fluxes are corrosive and are not suitable for certain products, particularly for electrical applications. Rosin is the most popular noncorrosive flux, although there are numerous proprietary fluxes also available.

If the parts to be joined have

internal stresses, they should be stress relieved before soldering. In addition, the assembly should not be stressed while the solder is molten. If stresses are present during soldering, solder may penetrate the base metal and cause cracking.

Brazing—Most of the nickel silvers can be joined readily by brazing. Both silver alloy (BAg) and copper alloy (BCuZn) filler metals can be used. In the latter group a white brass rod is available for matching the color of the base metal.

Generally, joints are made by flowing the molten filler metal into closely fitted assemblies of the components by capillarity. With the copper alloy filler metals, vee or fillet joints are also made, a procedure which is usually too expensive to be employed with the silver alloy filler metals.

Use of a silver filler metal on nickel silver yields a strong, ductile connection. Heating for brazing usually softens the base metal in the joint area. Whether a cold worked alloy is completely softened or retains most of its strength and hardness depends on the speed of the operation.

Regardless of the type of filler metal used, fluxes are necessary to obtain satisfactory joints. Fluxes based on boric acid or borax are commonly used with the copper filler metals; proprietary fluxes based on fluorides are used with the silver-bearing materials. Best results are obtained by using the fluxes suggested by the producer of the filler rod.

Welding—A number of welding processes are used in joining the nickel silvers. Because of their nickel content, the nickel silvers have relativey high electrical resistivity, and resistance welding procedures give excellent results. Surface preparation is important, since satisfactory welding is achieved only if the mating surfaces are clean and free from heavy oxide films. Heliarc welding and oxyacetylene welding are also used.

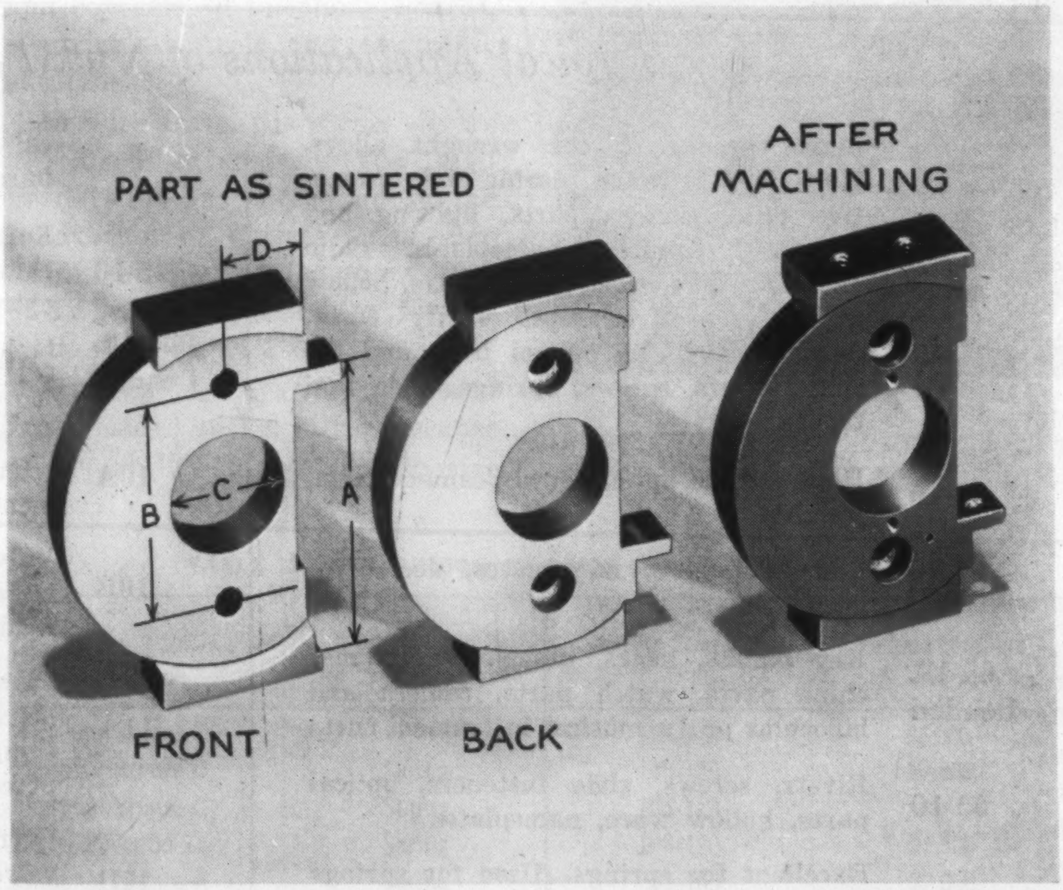
Spot, seam and projection welding can be performed easily on the nickel silvers but because of the relativey short plastic range of the materials, low inertia heads are desirable so that force can be applied rapidly. Electronic control of current and time also yields superior welds. Machine settings used for welding 0.036-in. sheet in high zinc brasses can be used for the nickel silvers. For example, such settings might be: 4 cycles, 400 lb and 21,000 amp.

Carbon arc welding of nickel silvers is less satisfactory than resistance welding and is not recommended. As in welding the brasses, consideration of the volatility of zinc is necessary to minimize losses by evaporation. Preheating is usually required. A copper-silicon rod with a suitable flux is necessary.

Oxyacetylene welding procedures used for brasses can be used for nickel silvers. Use of an oxidizing flame has been suggested to avoid zinc losses, but the flame can be less oxidizing than that used for the brasses since nickel reduces zinc losses. A suitable flux such as boric acid is required to dissolve nickel oxide and prevent porosity. The metal added shoud be of the same composition as the parts being joined and is often cut from the edge of the material being welded.

Adhesive bonding—Nickel silvers are joined by adhesive bonding, particularly in the production of silver plated flatware. Modern adhesives employed for metal joining, and the ability to join dissetting resins such as the phenolics or epoxies, or thermoplastic resins like the polyvinyls or acrylics. There are a number of proprietary compounds available.

Major advantages of this method of joining are the elimination of high temperatures for joining, and the ability to join dissimilar metals. Thus, for example, a stainless steel knife blade can be readily joined to a nickel silver handle. For service at ordinary temperatures, there are adhesives that can be cured at room temperature and others that cure under moderate pressures in the range 200 to 300 F. Adhesives



New Jersey Zinc Co.

Instrument dial plate support *produced from nickel silver powder in eight operations (including machining). Producing the same part from aluminum bar stock required 19 operations.*

that can be used at temperatures up to at least 500 F have also been developed.

Surface finishing

Cleaning—Grease, dirt and metallic particles picked up on the surface during fabrication can be removed by a number of mechanical or chemical cleaning methods.

Barrel tumbling is useful for deburring and removing tool marks from small parts. An abrasive such as pumice is suitable if the surface is reasonably clean. If degreasing is required, a solution of caustic soda in hot water can be used. If no deburring is necessary, a bright finish can be obtained on clean parts by tumbling in a solution of ¼ oz per gal of potassium tartrate.

Large parts can be cleaned by blasting with sand or copper shot. Steel shot may become imbedded in the surface and should be avoided. A modification of this process using a suspension of abrasive in water can also be used; it gives better control of the intensity of the abrasive action than dry blasting.

Alkaline cleaning removes surface dirt and oils. Inhibited types of cleaners should be used to prevent surface attack. Solutions can contain about 4 to 6 oz/gal of the cleaner and are operated at about 180 F. Electrolytic processes using inhibited cleaners can also be used. Anodic cleaning requires low current densities and short immersion time.

Coolants and cutting oils can be removed from small parts with solvent cleaners. Generally a low boiling solvent such as Stoddard solvent or mineral spirits is used and the bath is operated below 100 F. Vapor degreasing also removes oils and greases.

Pickling—Acid pickling can be used to remove oxides resulting from annealing. This is accomplished by dipping in a solution of 10% (by volume) sulfuric acid operating at temperatures up to about 150 F. Generally, the heavier the scale, the more concentrated the solution required. If staining occurs on the surface after pickling, it is probably due to excessive acid in the final rinse water. About 0.01% acid in the final rinse is about all that can be tolerated if staining from this source is to be prevented.

After the scale has been competely removed by pickling in sulfuric acid, the surface has a matte finish. The part can be brightened by dipping in a solution containing ½ to 1 gal of sulfuric acid and 2 to 5 lb of sodium dichromate to 10 gal of water held at 80 to 120 F. A brighter finish is obtained with the standard brass bright dip which is composed of 2 gal sulfuric acid, 1 gal nitric acid, ½ fluid oz hydrochloric acid and 1 qt water. This dip is used at room temperature.

Mechanical finishing — Nickel silvers can be finished by mechanical polishing. Cloth, felt or sheepskin polishing wheels loaded with alumina or emery can be used for initial polishing. Buffing is done with a compound that gives the

Typical Applications of Nickel Silvers

65-18	Most popular of the wrought alloys. Used for hardware, marine and automotive trim, camera parts, lighting and plumbing fixtures, nameplates, radio dials, costume jewelry, tableware, hollow ware, surgical clamps, vanity cases, cigarette lighters, optical bows and fittings, rivets, screws, springs, slide fasteners
65-15	Hollow ware, optical goods, camera parts, jewelry
65-12	Slide fasteners, nameplates, decorative trim, camera parts
65-12, Leaded	Key blanks, gears, pinions, screw machine parts, watch parts, camera and binocular parts, musical instrument parts
65-10	Rivets, screws, slide fasteners, optical parts, hollow ware, nameplates
55-18	Excellent for springs. Used for springs and contacts in telephone equipment, electrical controls, resistance wire, surgical and dental instruments, diaphragms, hardware, extruded shapes
45-10	Refrigerator hardware, bathroom fixtures, chlorine gas cylinder valves, forgings, extruded architectural shapes
46.5-10, Leaded	Extruded shapes
10A	Hardware fittings, valves and valve trim, plumbing fixtures, statuary, ornamental castings
10B	Valves and fittings, pipe fittings, hardware, plumbing fixtures, boat and railroad car fittings, ornamental castings
11A	Plumbing goods, valves and fittings, marine castings, hardware, mechanical equipment, parts for bottling and food processing equipment, ornamental fixtures
11B	Corrosion resistant parts, dairy fittings, valves and valve fittings for elevated temperatures, hardware, ornamental castings, musical instrument keys

desired finish, e.g., Tripoli.

Plating—Nickel silver is widely used as the base for silver plated tableware and jewelry. Because of its color, it retains a silver-like finish even after the silver layer has worn off. Coatings are produced by standard electroplating procedures or by chemical replacement. Electroplating is used on tableware and some jewelry, the coating thickness on tableware running about 1 to 2 mils. Chemical replacement coatings are used mainly on inexpensive jewelry and may be only a few millionths of an inch thick. Because it normally does not require preplating or flash coating, nickel silver is especially adapted to chromium plating. A high polish is sufficient to yield a smooth, adhering plate.

Coating—Suitable lacquer coatings can be used to protect highly polished surfaces of nickel silver parts. Clear cellulose lacquer is often used for parts to be exposed to indoor atmospheres, but outdoor exposure requires coatings which are more resistant to light. Cellulose acetate butyrate or methyl methacrylate coatings have been suggested for such exposure. These coatings are normally about 1 to 2 mils thick.

Applications

Applications of nickel silvers are based to a large extent on two qualities: color and corrosion resistance. Excellent resistance to foods leads to wide application of the cast alloys in food processing equipment. Resistance to salt water is responsible for selection of the alloys for marine fittings, particularly for deck service. Color is responsible for the wide usage of the nickel silvers in slide fasteners, silver plated tableware, jewelry and ornamental objects. Ability to be readily chromium plated makes the metal a desirable base for cosmetic cases.

The greatest tonnage of nickel silver castings is used in food handling equipment. Valves, fittings and similar parts, cast from type 11B, are used in dairy equipment. Their resistance to corrosion prevents contamination and protects the flavor of the milk. In addition, bottling and food packaging machinery are built extensively from nickel silver.

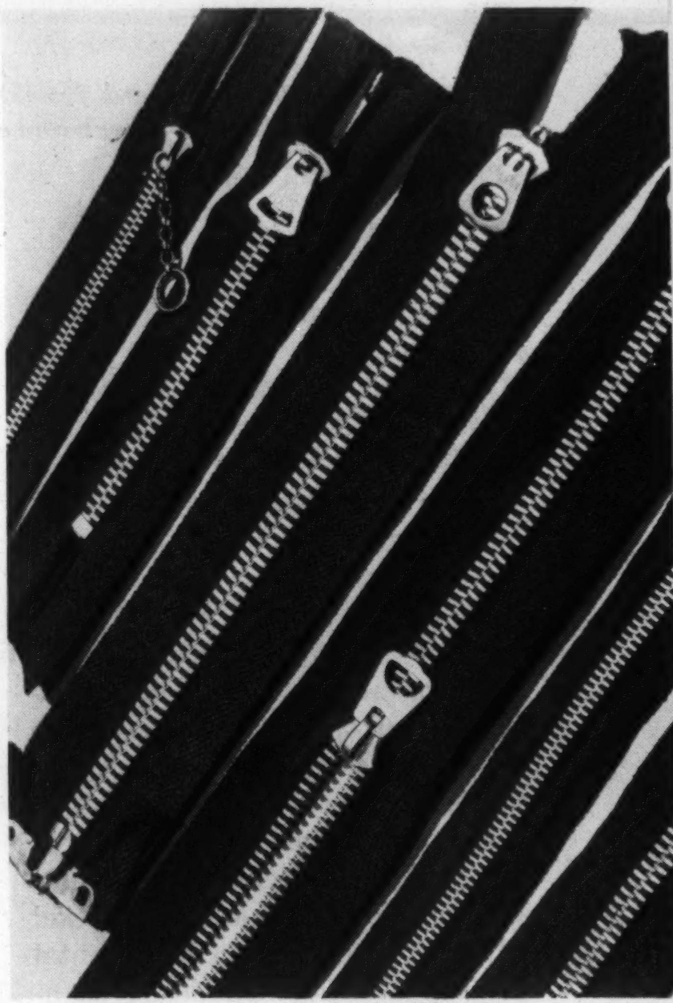
Nearly every manufacturer of silver plated flatware uses nickel silver (10 to 18% nickel). These alloys are strong and resistant to corrosion by organic materials, and they closely resemble silver in color. The last reason is probably the most important since, wearing of the silver plate at critical points is not readily apparent. Nickel silver is widely used in silver plated hollow ware for the same reasons.

Nickel silvers can be plated with chromium, nickel and silver without difficulty and are used in the production of novelty jewelry, compact and cigarette cases, and ornamental objects.

Because of its high strength and good elastic properties, 55-18 is widely used for springs. In resistance to fatigue, spring temper 55-18 is exceeded among copper alloys only by beryllium copper and certain of the phosphor bronzes (see Table 12). Applications include diaphragms, spring parts in optical goods, and surgical and dental instruments. The high electrical resistivity of 55-18 insures wide use for spring parts and contacts in telephone boards, electrical controls and electronic equipment.

In wire form, the nickel silvers are used extensively for high grade slide fasteners and in the production of optical parts, fine chain, jewelry and fasteners. The 55-18 grade is used also for resistance wire.

Millions of keys are produced from leaded nickel silver because of its ability to resist corrosive



Scovill Mfg. Co.

***Slide fasteners** are a major application of nickel silver wire.*

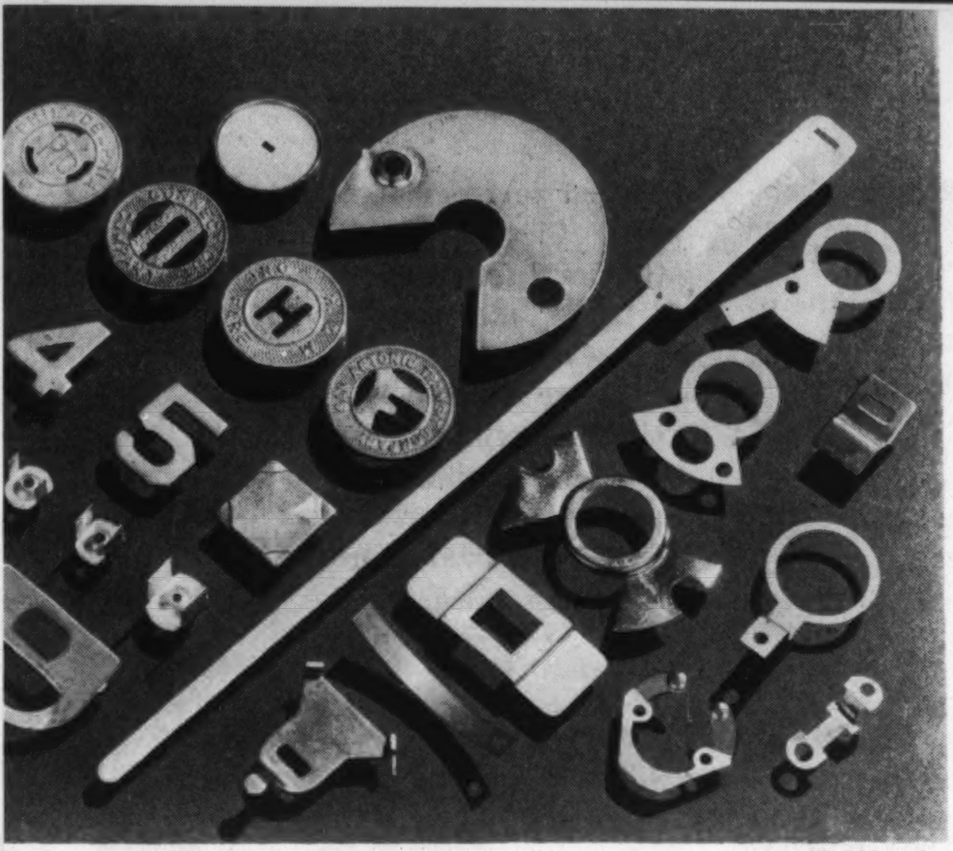
TABLE 12—COMPARISON OF SOME SPRING MATERIALS

Material	Temper	Tensile Strength, 1000 psi	Fatigue Strength, 1000 psi
Beryllium Copper	[a]	185-215	36,000 [b]
Phosphor Bronze D	Spring	115-129	27.000
Phosphor Bronze C	Spring	105-119	—
Nickel Silver 55-18	Spring	108-120	22.500
Phosphor Bronze A	Spring	91-105	22.000

[a] Cold worked and precipitation hardened.

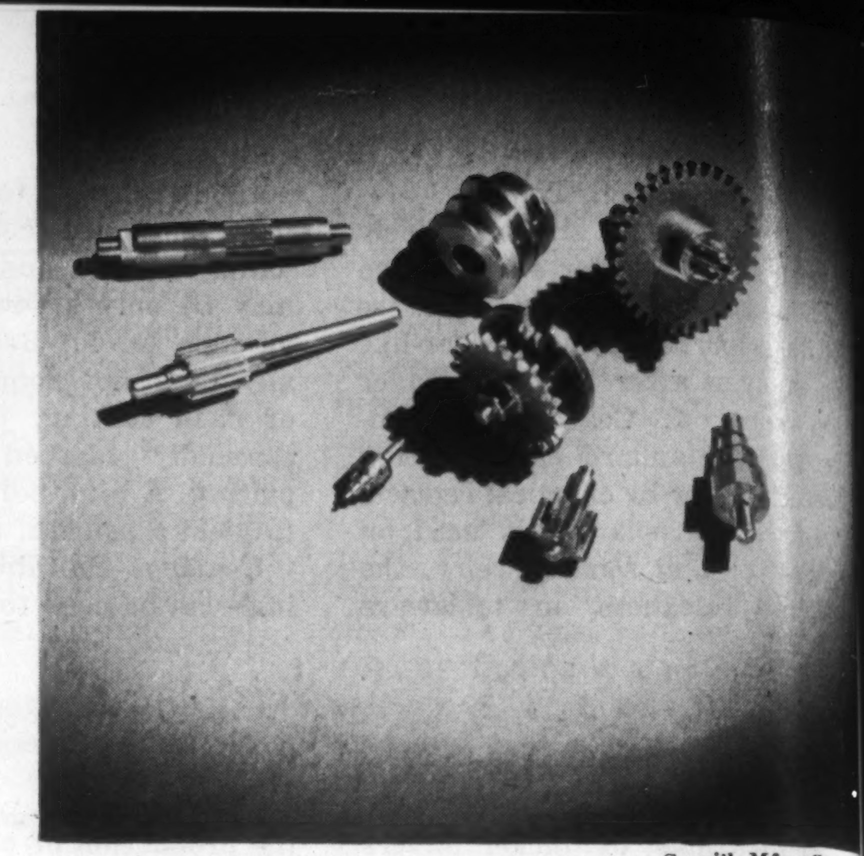
[b] Fatigue strength of beryllium copper having tensile strength shown in table is now usually given as 38,000-48,000 psi.

Source: *Metals Handbook*, 1954 supplement.



Scovill Mfg. Co.

A variety of parts *produced from nickel silver sheet. The nickel silvers have excellent cold working characteristics.*



Scovill Mfg. Co.

Gears and pinions *and other screw machine products are produced from leaded nickel silver rod because of its good machinability.*

attack, wear and high torsional strains.

Excellent resistance to corrosion by salt and fresh waters and ease of machining are the basis for the selection of nickel silver for fishing reels and rod fittings.

Nickel silver is used in the home and in public buildings for faucets, washbowls, flush valves and similar functional and ornamental purposes. The alloys are highly resistant to tap water, and the bright finish is readily cleaned and maintained. Hardware uses include hinges, locks, door handles and refrigerator handles. Nickel silver is also used in ornamental grilles, stairway banisters, chandeliers and railings. Other ornamental applications include book ends, statuary, candlesticks and plaques.

Nickel silver powders are used to produce various small parts. These include aircraft gyro clamps, instrument dial plate supports, time recorder guide blocks, camera tripod parts and shower heads.

Acknowledgment

The assistance received in the preparation of this manual from the personnel and publications of the following organizations is gratefully acknowledged:

American Brass Co.
American Smelting and Refining Co.
Bridgeport Brass Co.
Copper and Brass Research Assn.
International Nickel Co.
R. Lavin & Sons, Inc.
New Jersey Zinc Co.
North Electric Co.
Revere Copper and Brass, Inc.
Riverside Metal Co., Div of H. K. Porter Co., Inc.
Scovill Mfg. Co.
Seymour Mfg. Co.
Titan Metal Mfg. Co.
Waterbury Rolling Mills, Inc.

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Reprints of this Manual are available at 35¢ each until supply is exhausted. See page 196 for complete list of available Manuals. Write for quotations on quantities of 100 or more. Address requests to Reader Service Dept., MATERIALS & METHODS, 430 Park Ave., New York 22, N. Y.

MATERIALS ENGINEERING FILE FACTS

Properties of Commercial Refractory Oxides

Properties	Alumina	Beryllia	Calcia	Magnesia	Silica (Crystalline)	Silica (Vitreous)
Formula	Al_2O_3	BeO	CaO	MgO	SiO_2	SiO_2
Melting Point, F	3660	4620	4710	5070	3140	—
Max Use Temp in Oxidizing Atm, F	3540	4350	4350	4350	3055	—
Mohs Hardness	9	9	4.5	6	7	—
Coef of Expansion, per °F	44×10^{-7} (68–2875 F)	52.8×10^{-7} (68–2550 F)	75.5×10^{-7} (68–2190 F)	77.8×10^{-7} (68–2550 F)	238.9×10^{-7}[a] (68–570 F)	2.8×10^{-7} (68–2280 F)
Ther Cond (at specified temperature and porosity) Btu/sq ft/hr/F/in.	16.5 (2190 F, 23%)	114.1 (2190 F, 5–10%)	49.4 (1830 F, 9%)	17.7 (2190 F, 22%)	11.0 (2010 F)	9.6 (0.9%)
Thermal Shock Resistance	Good	Excellent	Fair	Fair	Poor to 600 F, excel above 600 F	Excellent
Stability in:						
Reducing Atmosphere	Good	Excellent	Poor	Poor	Poor	Fair
Carbon	Fair	Excellent	Poor	Good	Poor	Good
Acid Slags	Good	—	Poor	Poor	Good	Good
Basic Slags	Good	Fair	Fair	Good	Poor	—
Metals	Good	Good	Fair	Fair	Poor	—

Properties of Commercial Refractory Oxides (continued)

Properties	Thoria	Zirconia (Stabilized)	Mullite	Spinel	Zircon
Formula	ThO_2	ZrO_2	$3Al_2O_3$-$2SiO_2$	MgO-Al_2O_3	ZrO_2-SiO_2
Melting Point, F	6000	4710	3330[b]	3830	4390
Max Use Temp in Oxidizing Atm, F	4890	4530	3270	3450	3400
Mohs Hardness	7	7–8	6–7	8	7.5
Coef of Expansion, per °F	52.8×10^{-7} (68–2550 F)	30.6×10^{-7}[c] (68–2190 F)	25×10^{-7} (68–2410 F)	50×10^{-7} (68–2280 F)	30.6×10^{-7} (68–2190 F)
Ther Cond (at specified temperature and porosity), Btu/sq ft/hr/F/in.	0.0 (2190 F, 17%)	6.4 (2190 F, 28%)	18.6 (2190 F, 30%)	14.5 (2370 F, 36%)	14.5 (1830 F, 30%)
Thermal Shock Resistance	Poor	Fair	Fair	Poor	Good
Stability in:					
Reducing Atmosphere	Good	Good	Fair	—	Fair
Carbon	Fair	Fair	Fair	Fair	Fair
Acid Slags	Poor	Good	Good	Fair	Good
Basic Slags	Good	Poor	Fair	Good	Poor
Metals	Excellent	Good	Fair	—	Good

[a] Depends on crystalline form. At temperatures of 570 to 2010 F, value is 16.6 per F.

[b] Incongruent.

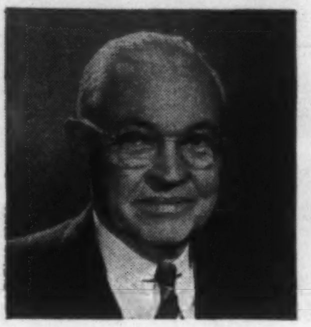
[c] Depends on degree of stabilization.

Source: Campbell, I. E., *High Temperature Technology*, John Wiley & Sons, Inc., New York, N. Y., 1956 (sponsored by Electrochemical Society).

◀ For more information, Circle No. 553

RB&W FASTENER BRIEFS

RUSSELL, BURDSALL & WARD BOLT AND NUT COMPANY



Technical-ities

By John S. Davey

Bolts take greatest stress during wrenching

If a bolt doesn't fail when being wrenched up tight, it won't fail in service (assuming bolts and joint have been designed adequately for the loads).

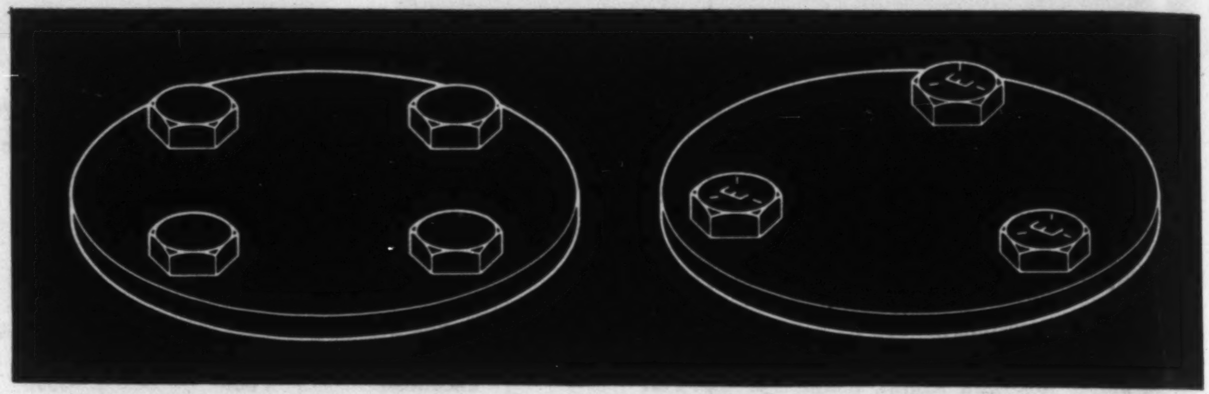
That's because two forces put stress on bolts (and cap screws) as they tighten: Tension due to bolt stretch; torsion due to friction. But only tension remains after wrenching. In a rigid joint, if this tension exceeds external forces, bolts will never experience any further strain, and will therefore not loosen or fail.

WHY SOME FAILURES?

Obviously, unusual unforeseen loads cause trouble. The instant they exceed residual tension, *they add* to the stress placed on the bolt and can cause *immediate* failure. Or they can cause loosening, leading to stress change, which in turn causes fatigue and failure. That's why you've got to torque bolts tight . . . and the tighter the better.

An exception: A flexible joint. With high cyclic loading, again loosening and fatigue cause trouble. Since you shouldn't tighten such a joint too much, sometimes the only remedy is to take out the flexible element and put in a rigid joint. (A metal to metal flange connection instead of a gasketed one, for example.)

Are you using more bolts than needed?



The stability of a 4 bolt arrangement can be matched by a 120° spacing of 3 bolts. Strength can be actually increased by using RB&W high carbon heat treated bolts (identified by "E" and three radial dashes).

NOBODY wants to use too few bolts or cap screws and risk failures. But using too many is not the best answer either. It means too many holes to drill, to fill — both costly.

RB&W offers some suggestions.

BALANCED BOLT PATTERN

By "rule of thumb," bolts are generally arranged symmetrically in a pattern of four. Yet three bolts 120° apart around a common center will prove just as stable, and save on assembly. With stability assured, the problem is then one of load capacity.

PRELOAD TO GET FULL CAPACITY

In checking size and number of bolts, calculate the stress and get rid of the excess. You have enough if you've allowed for usual factor of safety . . . *and the fasteners are tightened so that residual tension exceeds maximum external load anticipated.* If they are, you have safety. The bolts will *stay* tight, won't fatigue, won't fail.

With RB&W standard fasteners, engineers and production men can take quality, uniformity and dependability for granted — and can concentrate on the problem of proper application and assembly. For help or information on your specific product, write Russell, Burdsall & Ward Bolt and Nut Company, Port Chester, N.Y.

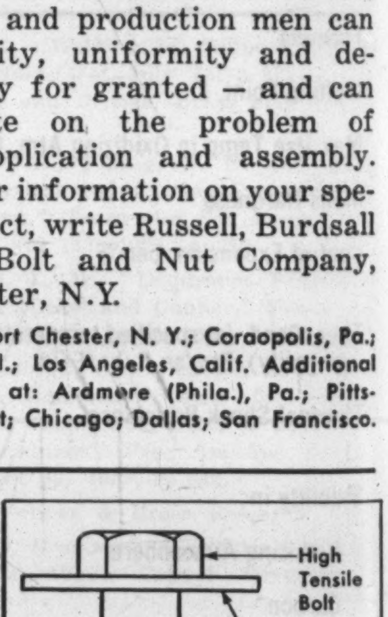
Plants at: Port Chester, N. Y.; Coraopolis, Pa.; Rock Falls, Ill.; Los Angeles, Calif. Additional sales offices at: Ardmore (Phila.), Pa.; Pittsburgh; Detroit; Chicago; Dallas; San Francisco.

High strength bolts stop joint failure from vibration

Shakeout equipment used by one company for unloading coal cars applied its vibration via a fabricated frame lowered onto the cars. This frame was originally riveted.

But it was a constant source of maintenance. About every 10 days, the frame had to be welded, loosened rivets replaced. Finally it was refastened with RB&W high tensile bolts and hardened washers. Maintenance now is *nil!*

Proving again that high strength bolts make the strongest connection for the severest service.



For more information, turn to Reader Service Card, Circle No. 504

DECEMBER 1956

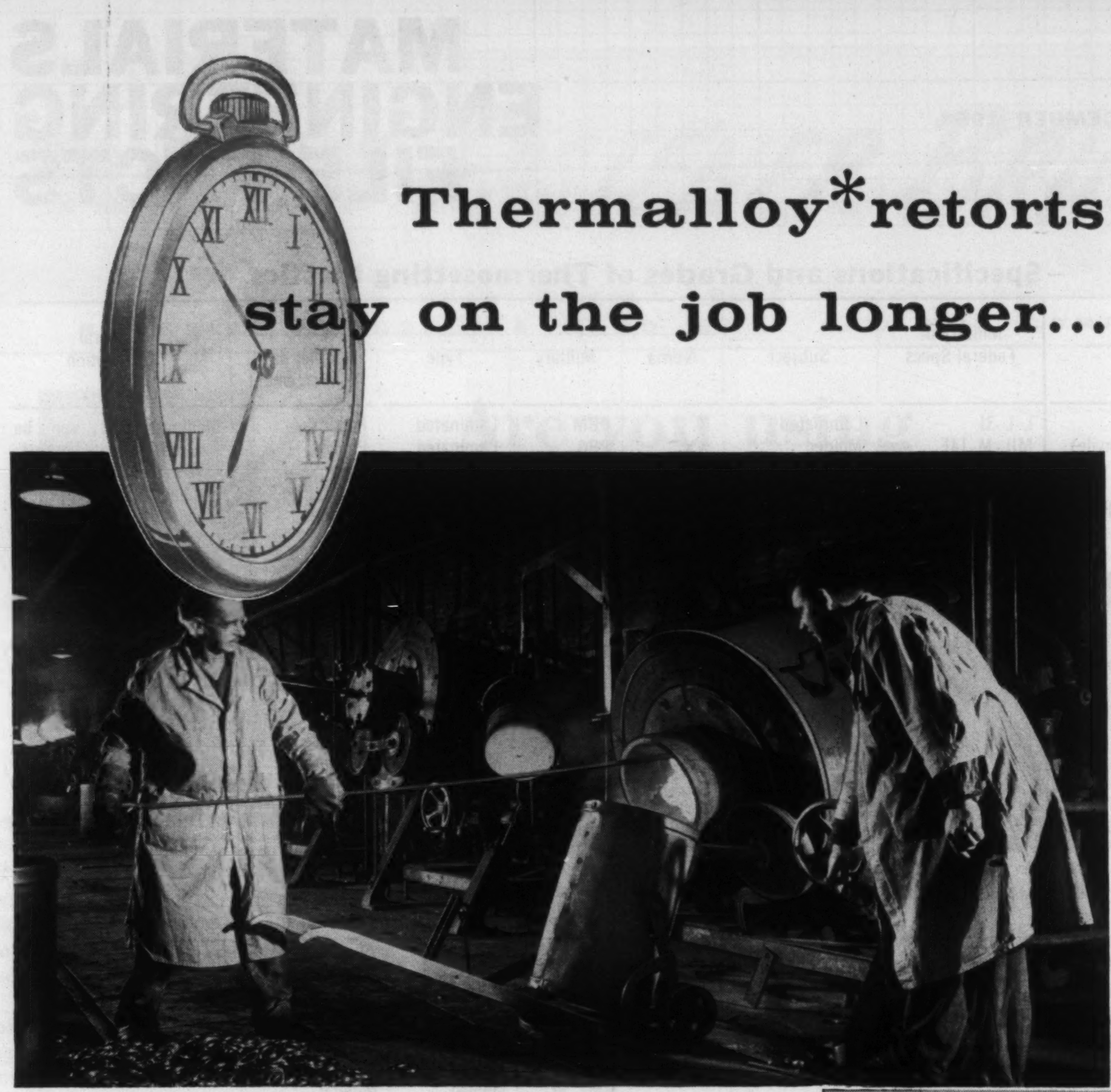
MATERIALS ENGINEERING FILE FACTS

Specifications and Grades of Thermosetting Plastics

Resin	Military or Federal Specs	Subject	Grades				General Description
			Nema	Military	Type	Filler or Reinforcement	
Phenolic (Phenol-Formaldehyde)	L-L-31	Laminated	X	PBM	Laminated	Paper	Moderate cost; can be molded, laminated or cast; easily machinable; good mechanical strength; withstands wide temperature range; moderate moisture resistance; available with a wide variety of fillers or reinforcing materials
	MIL-M-14E	Molded	XX	PBG	Laminated	Paper	
	MIL-P-77A	Cast	XXX	PBE	Laminated	Paper	
	MIL-P-78A	Name Plates	XXXP	PBE-P	Laminated	Paper	
	MIL-P-79B	Rods & Tubes	C	FMB	Laminated	Fabric	
	MIL-P-3115B	Paper-Base Sheets	CE	FBG	Laminated	Fabric	
	MIL-P-6885	High Strength Sheets	L	FBI	Laminated	Fabric	
			LE	FBE	Laminated	Fabric	
	MIL-P-8655A	Cotton Fabric	N-1	NPG	Laminated	Nylon	
	MIL-P-15035B	Cotton Fabric	A	—	Laminated	Asbestos	
	MIL-P-15047B	Nylon Fabric	G-1	—	Laminated	Glass	
	MIL-P-13436A	Fiber-Filled, Uncured	G-2	—	Laminated	Glass	
			G-3	—	Laminated	Glass	
				CFG	Molded	Cellulose	
				CFI	Molded	Cellulose	
				MFE	Molded	Mineral	
				MFG	Molded	Mineral	
				MFH	Molded	Mineral	
				MFI	Molded	Mineral	
				M-1	Cast	—	
				PMS	Uncured Sheet	Short Fibers	
Melamine (Melamine-Formaldehyde)	MIL-P-15037B	Glass Cloth	G-5	GMG	Laminated	Glass Cloth	Hard, strong, mar resistant; withstands wide temperature range; arc resistant; inert to common solvents, greases, oils, etc.
	MIL-P-17721C	Glass Mat	MC	—	Laminated	Fabric	
	MIL-M-14E	Molded	G-8	GMM	Laminated	Glass Mat	
				CMG	Molded	Cellulose	
				CMI	Molded	Cellulose	
				MME	Molded	Mineral	
				MM1-30	Molded	Mineral	
Epoxy (Epichlorohydrin Bisphenol)	MIL-P-18177	Glass Cloth	G-10	GEE	Laminated	Glass Cloth	Good moisture resistance; good electrical properties at high frequencies and high humidity; excellent adhesion
Silicone (Polysiloxanes)	MIL-P-997B	Glass Cloth	G-7	GSG	Laminated	Glass Cloth	Extremely heat resistant; excellent arc resistance; good dielectric properties
	L-L-31	Sheets, Tubes and Rods	G-6	—	Laminated	Glass Cloth	
Polyester	MIL-R-7575A	Low Pressure Laminate	—	MDG	Molded	Mineral	Can also be thermoplastic; good electrical properties; good resistance to moisture and chemicals; physical properties range from hard and rigid to flexible; can be made into films
				I	Laminated	Glass Cloth	
	MIL-P-8013B	Glass Fabric	—	II	Laminated	Glass Cloth	
	MIL-P-4389	Molded	—	III	Laminated	Glass Cloth	
	MIL-M-14E	Molded	—	—	—	—	
	MIL-P-8257A	Transparent Sheet	—				
Alkyd (Glyptal)	MIL-M-14E	Molded	—	MAG	Molded	Mineral	Highest arc resistance; good electrical properties; will retain inserts without cracking or crazing
				MA1-60	Molded	Mineral	
Allyl	MIL-P-77B	Cast	—	G-3	Cast	—	Hard; can be optically clear; high temperature resistance; immune to most solvents, acids and bases; good electrical properties
Styrene Copolymer	MIL-P-77A	Cast	—	E-2	Cast	—	Excellent electrical properties at high frequencies, very low loss, somewhat brittle, supports combustion

Courtesy of K. H. McPhee, Materials Engineer, Collins Radio Co.

Thermalloy*retorts stay on the job longer...

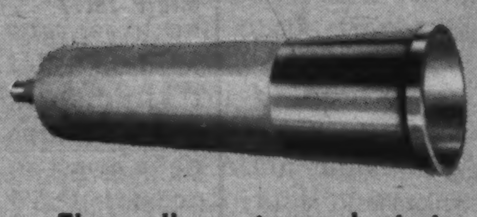


A large ball and roller bearing company found retort service life increased 30% after they installed Thermalloy retorts. The retorts were used to heat-treat ball-thrust bearing races at an average temperature of 1750°F. for five continuous hours. The specially designed octagonal shape also provided more uniform tumbling action with less marring of parts.

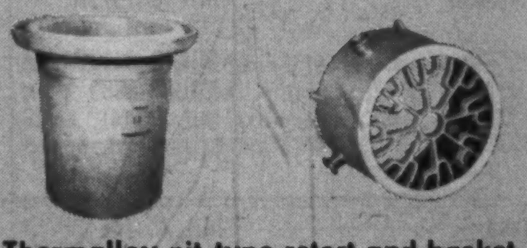
In our Elyria foundry, the most modern facilities are available to turn out quality high-alloy castings. In addition, retorts and muffles are X-ray inspected and pressure tested before shipment to make sure your Thermalloy castings give longer hours of trouble-free service.

For further information on Thermalloy retorts, write for Bulletin T-239. Electro-Alloys Division, 70212 Taylor St., Elyria, Ohio.

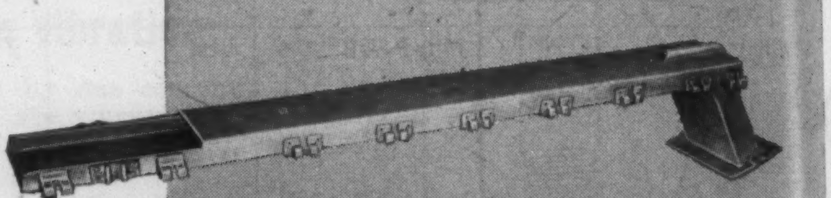
*Reg. U. S. Pat. Off.



Thermalloy octagonal retort



Thermalloy pit-type retort and basket



Thermalloy shaker hearth muffle

AMERICAN **Brake Shoe** COMPANY

ELECTRO-ALLOYS DIVISION
Elyria, Ohio

For more information, turn to Reader Service Card, Circle No. 362

NEW MATERIALS PREVIEWS

This month

- *High temperature magnesium alloy*
- *Ceramic fiber blanket, other new materials, p 141*

Magnesium-Thorium Alloy for High Speed Aircraft

■ A new and improved high temperature magnesium-thorium sheet alloy, called HM21XA-T8, has been announced by *Dow Chemical Co.*, Midland, Mich. The alloy was developed for aircraft and missile applications. (This material was mentioned briefly in the October issue, p 148.)

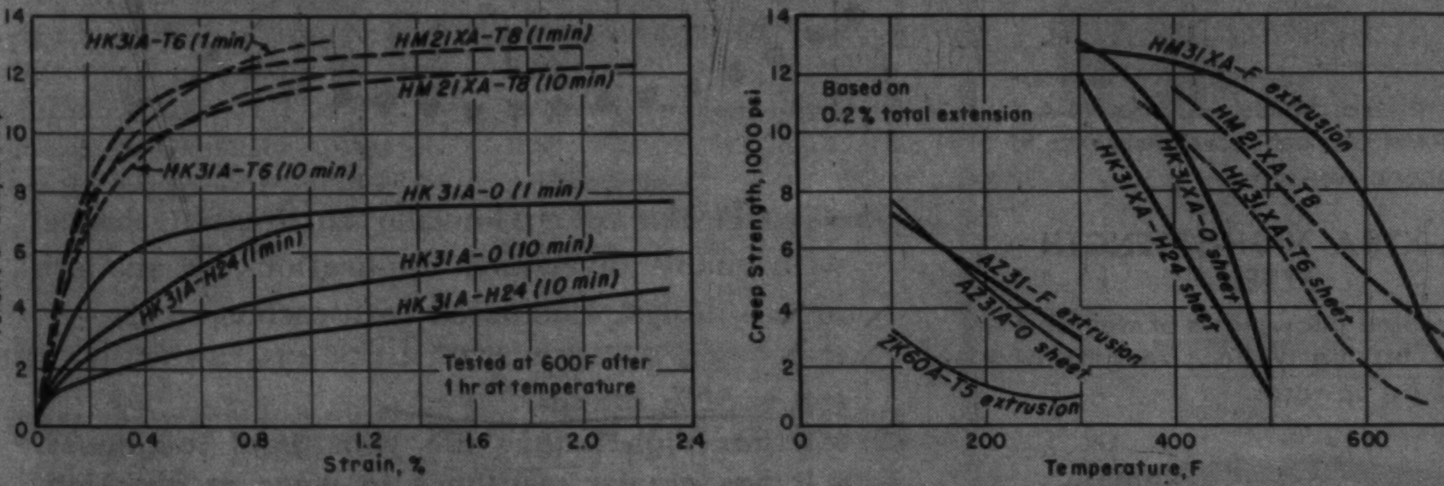
According to Dow engineers, the new alloy is suitable for "temperature applications in excess of 300 F where light weight and stiffness are musts; and at any temperature above 500 F where particularly long exposures are required."

The second in a series of high temperature magnesium-thorium alloys developed by the company (see M&M, Mar 1956, p 114), the new alloy is intended to supplement the first in the series, HK31A-H24. Testing of the alloy continues and minor revisions in physical property data may be anticipated. A limited stock is now available from initial production in the final heat treated state for customer evaluation. Heat treatment of the alloy by the user is not necessary.

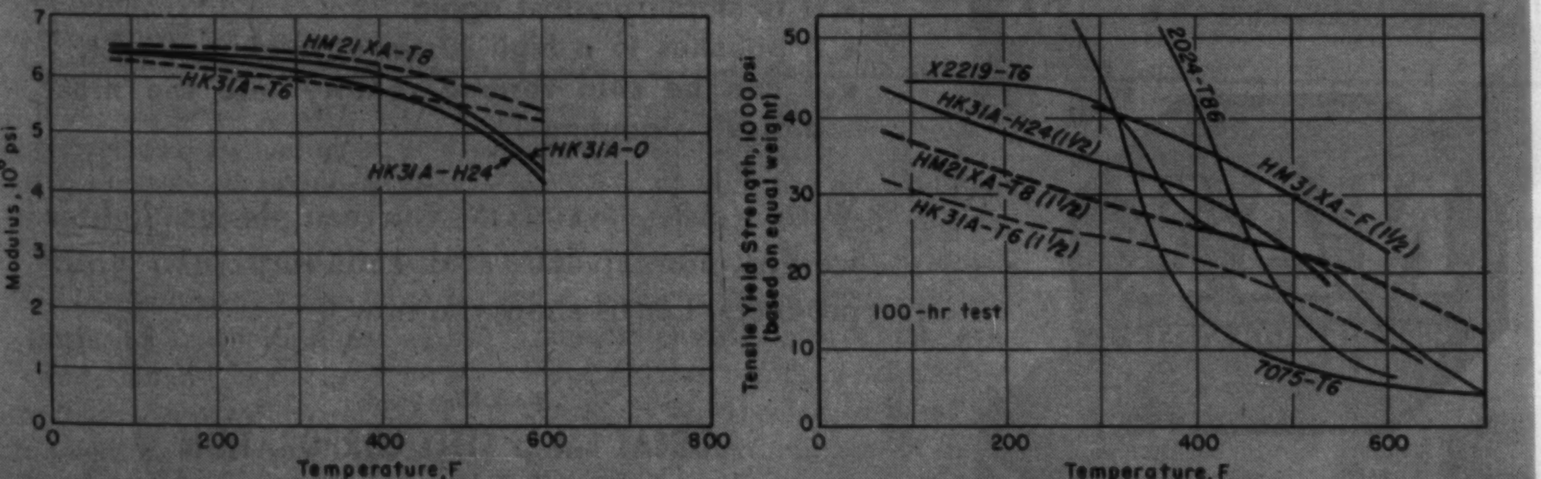
Physical properties

The magnesium alloy contains 1.5-2.5% thorium and 0.35-0.80%

Comparative Properties at Elevated Temperatures



Isochronous stress-strain. **100-hr creep.**



Modulus of elasticity. **Tensile yield strength.**

Presenting...

N-A-X® FINEGRAIN

Latest member of
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High-Strength Steels

COMPANION HIGH-STRENGTH STEELS TO N-A-X FINEGRAIN

N-A-X HIGH-TENSILE STEEL

A low-alloy, high-strength steel possessing all of the characteristics of N-A-X FINEGRAIN plus enhanced resistance to atmospheric corrosion.

N-A-XTRA HIGH-STRENGTH STEEL

Heat-treated alloy plates of weldable quality having yield strengths of 70,000 psi upwards.

MAKE IT WEIGH LESS

N-A-X

HIGH-STRENGTH STEELS

MAKE IT LAST LONGER

N-A-X FINEGRAIN is a low-alloy, high-strength steel with many diversified applications in modern metals design. Compared with carbon steel—

- **It is 50% stronger.**
- **It has high fatigue life with great toughness.**
- **It has greater resistance to wear or abrasion.**
- **It is readily welded by any process.**
- **It is stable against aging.**
- **It polishes to a high luster at minimum cost.**
- **It can be cold formed readily into the most difficult stampings.**

With N-A-X FINEGRAIN you can design lighter weight, longer life and economy into your products. Let us show you how.

N-A-X Alloy Division
GREAT LAKES STEEL CORPORATION
Detroit 29, Michigan • A Unit of
NATIONAL STEEL CORPORATION

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manganese. Fabricating procedures are generally similar to those for other magnesium alloys.

The alloy, described as a structural airframe material that combines light weight and strength with the ability to withstand the intense heat generated by friction at supersonic speeds, is said to withstand prolonged exposure at 700 F for as long as 100 hr with little effect on its properties. The alloy is also said to offer superior resistance to creep at elevated temperatures.

Fabrication

In bending tests conducted on the sheet alloy, it was found that no significant change in bend radius occurred from room temperature (70 F) to 500 F. The company recommends that parts requiring bends sharper than can be made at room temperature be bent at 600 to 800 F. Preheating the parts to 700 F and the bending dies to 400 F is said to make possible bends of 3.5 t, equivalent to those obtained at 600 F.

In drawing operations the sheet alloy requires temperatures of 700 to 750 F, with drawing speeds up to 12 in. per min being satisfactory. Punch temperatures of 350 to 400 F are recommended for the alloy. Though tests indicate that the material can be drawn satisfactorily, generous radii on drawing dies are recommended.

In preliminary tests the material shows good weldability with practically no tendency toward weld cracking. Tests indicate 100% efficiency at elevated temperatures after welding.

OTHER NEW MATERIALS PRODUCTS

Ceramic Fiber Blanket

Closely intertwining aluminum silicate fibers, called Fiberfrax ceramic fibers are now being used in a high temperature insulation blanket. Introduced by *Carborundum Co.*, Niagara Falls, N. Y., the Fiberfrax blanket is said to keep its form and properties at temperatures as high as 2300 F. (A Fiberfrax rope insulation was described in M&M, May '56, p 178.)

The blanket may be used on high pressure steam lines, diesel exhausts, gas turbines and furnace ducts. Claimed to have good chemical resistance, it may also be used as an insulation lining in alloy and refractory furnaces without harm from the furnace atmosphere. The blanket, made without organic binders, is available in 25-ft rolls 12 in. wide with a thickness of ½ in. Other sizes are currently being developed.

***Wrapping** a ceramic fiber blanket around a pipe used as a high temperature steam line.*

Color fastness, ease of care make . . .

New Synthetic Fiber Promising

Development of a new synthetic textile fiber, called Zefran, has been announced by *Dow Chemical Co.*, Midland, Mich. Described as a nitrile alloy, the material is currently being evaluated in pilot plant production. Commercial production is expected in 1958 at a new Dow plant near Lee Hall, Va.

Said to combine the ease of care properties of synthetic fibers with the exceptionally versatile dyeing characteristics of cellulosic fibers, such as cotton and rayon, the synthetic textile fiber is claimed, in addition, to have good initial whiteness, bleachability and wear resistance. It is also said to have good resistance to rot and chemicals, freedom from serious piling tendencies, and excellent dimensional stability when exposed to elevated temperatures.

The new fiber will be available in forms (staple length, denier, crimp) suitable for economical and efficient processing by the common textile processing systems and for blending with other fibers. It is expected to be of interest to manufacturers of most classes of textile goods, including upholstery fabrics and heavy industrial fabrics.

PROPERTIES OF ZEFRAN

Tenacity[a], gm/denier:	
Dry	3.5
Wet	3.1
Elongation[a], %	
Dry	33
Wet	33
Yield[a], gm/denier	0.98
Loop Tenacity[a], gm/denier	1.4
Specific Gravity	1.19
Moisture Regain[a], %	2.5
Refractive Index	1.5115
Flammability[b]	AATCC Class I Normal
Chemical Resistance:	
Acids	Good
Solvents	Good
Oils	Good
Greases	Good
Alkalies	Moderate
Dimens. Stab.	Excellent
Recovery Behavior	Good

[a] At 70 F, 65% R.H.

[b] Dependent on fabric geometry.

DON'T COMPROMISE ON DESIGN FREEDOM!

Now, your equipment can be lighter, stronger, tougher—made with economical new Lukens "T-1" steel!

■ The unique qualities of this amazing new material offer you greater design freedom than ever before in a high-strength steel! It has unusual resistance to impact, abrasion and atmospheric corrosion. It's tough and *stays* tough at low temperatures. And it combines these qualities with *triple* the yield strength of ordinary carbon steel! These advantages are changing the design of equipment and machinery in a growing number of industries.

Users like new Lukens "T-1" steel because its strength and toughness mean lighter, more efficient equipment. Because such equipment lasts longer, delivers better overall performance. Because it means lower maintenance and replacement costs.

No wonder this remarkable steel is finding its way into so many new plans. And Lukens "T-1" steel can be had in the widest range of plate sizes available anywhere!

Whether you want specific product information or the best ways to make the most of it, write for 24-page illustrated booklet LUKENS "T-1" STEEL, to Manager, Marketing Service, 850 Lukens Building, Lukens Steel Company, Coatesville, Pennsylvania.

Whatever your plans—now's the time to change to . . .

LUKENS "T-1" STEEL

LUKENS

THE NEWEST IN A COMPLETE LINE OF ALLOY STEELS
LUKENS STEEL COMPANY, COATESVILLE, PENNSYLVANIA

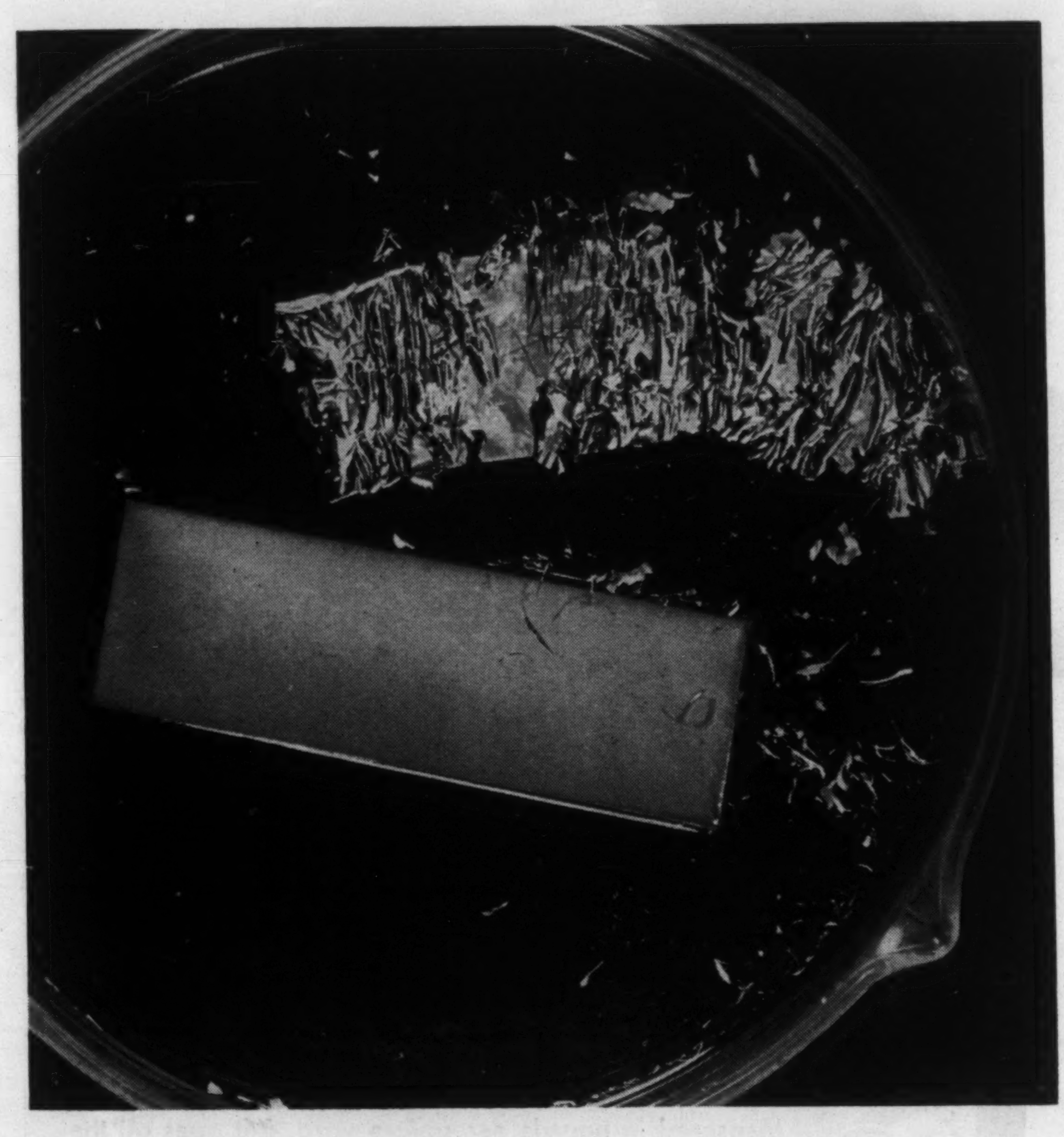
For more information, turn to Reader Service Card, Circle No. 412

Cracking and peeling of film eliminated with . . .

Compressively Stressed Rhodium Electroplate

A compressively stressed rhodium electroplate can be obtained by means of a process introduced by *Sel-Rex Precious Metals, Inc.*, Belleville, N.J. Known as Rhodex CS, the process (patent pending) is expected to be of interest in electrical and electronic applications. It is said to eliminate curling, cracking and peeling, which are common in conventional rhodium electroplates due to the metal's high tensile stress.

The new rhodium plate is also claimed to materially increase the fatigue resistance of the base metal.



***Dissolving** the base metal from two rhodium electroplated brass strips in this Pyrex dish caused the conventional rhodium electroplate (left) to disintegrate into small crystalline flakes. The compressively stressed electroplate (right) remained unimpaired and in a continuous film.*

High Strength Steel Bar Needs No Heat Treating

A free machining steel bar, called Fatigue Proof, is said to offer high tensile strength—in the range of 140,000 to 150,000 psi—without heat treating. Introduced by *La Salle Steel Co.*, Hammond, Ind., the bars are reported to be 25% faster in machining than annealed alloys and 50 to 100% faster than heat treated alloys.

Advantages claimed for the material are: 1) distortion from machining is held to a minimum; 2) no danger of quench cracks; 3) no expensive cleaning processes necessary; 4) distortion problems due to heat treating are eliminated; 5) physical properties are uniform from lot to lot, and from the outside to the center of the bar; 6) the bar is wear and fatigue resistant; and 7) it has uniform pearlitic structure.

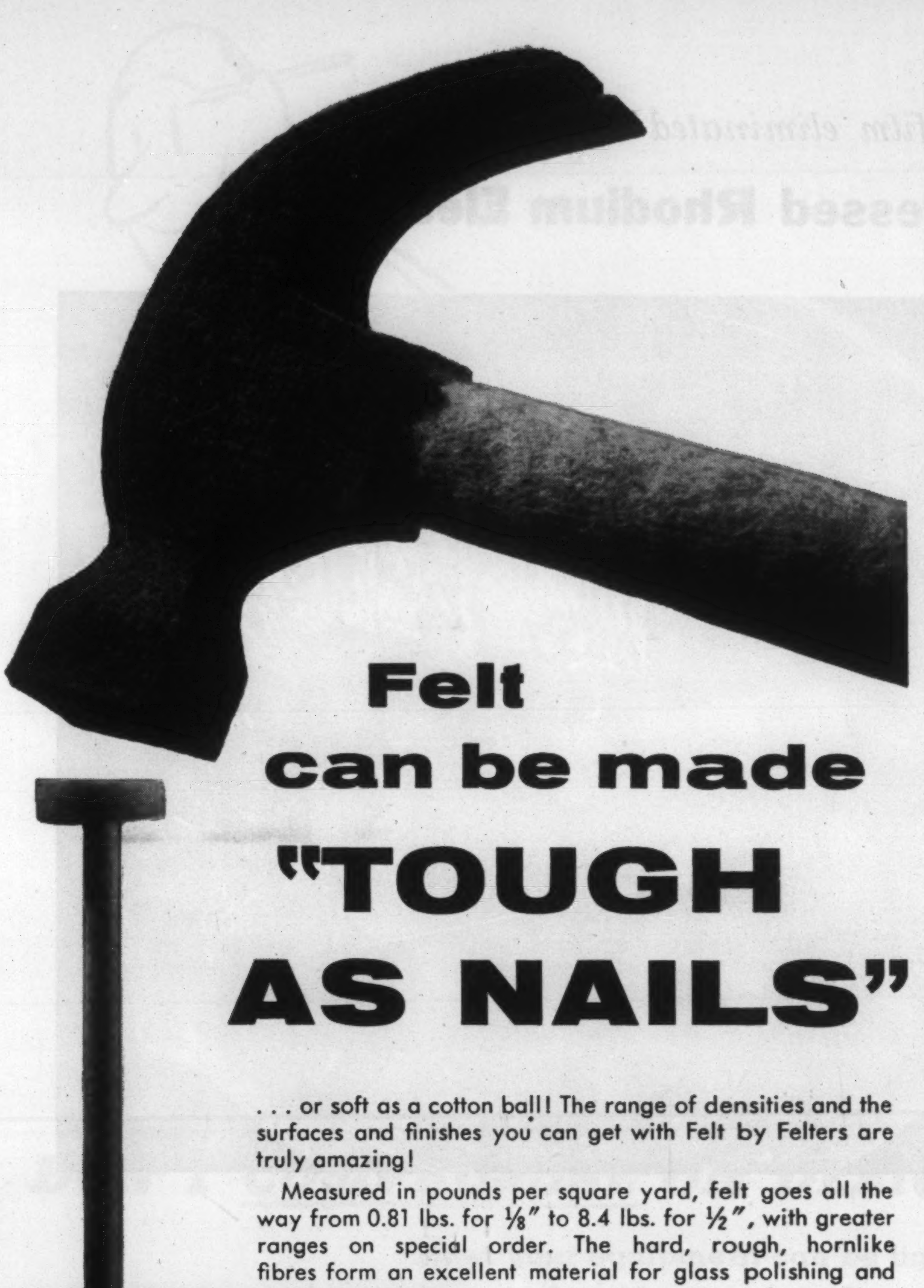
The manufacturer will ship a sample bar free of charge, provided that its Sales Planning Dept. believes the new steel bar can be used to advantage in the application under consideration.

COMPARATIVE PROPERTIES OF FATIGUE PROOF

Property	Fatigue Proof	4140[a]	4140[b]
Tensile Strength, psi	145,000	135,000	116,000
Yield Strength, psi	135,000	119,000	87,000
Elongation, %	7	16	15
Reduction of Area, %	25	50	46

[a]Quenched and tempered. [b]Quenched and cold drawn.

(more New Materials on p 144)


Felt can be made "TOUGH AS NAILS"

. . . or soft as a cotton ball! The range of densities and the surfaces and finishes you can get with Felt by Felters are truly amazing!

Measured in pounds per square yard, felt goes all the way from 0.81 lbs. for 1/8" to 8.4 lbs. for 1/2", with greater ranges on special order. The hard, rough, hornlike fibres form an excellent material for glass polishing and give exceptional wearing qualities when in contact with moving machinery parts. And fine, sanded surfaces are ideal for lubricating and filtering.

FELT IN USE . . . This manufacturer uses felt strips for buffing guides in their cylinder hones. Felt wears at same rate as stones to provide good bearing and cutting guide.

Send for FELTERS Design Book

20 pages of "Facts" on how you can use the unique properties of felt. It's yours for the asking, sent to help you build a better product. Send for it today: The Felters Company, 230 South Street, Boston 11, Mass.

Get the Best, Specify

Felt by Felters

230 South St., Boston 11, Mass. Manufacturers of Felt and Felt Products

FES-26

For more information, turn to Reader Service Card, Circle No. 538

OTHER NEW MATERIALS PRODUCTS

Tin-Clad Nickel Strip for Precision Soldering

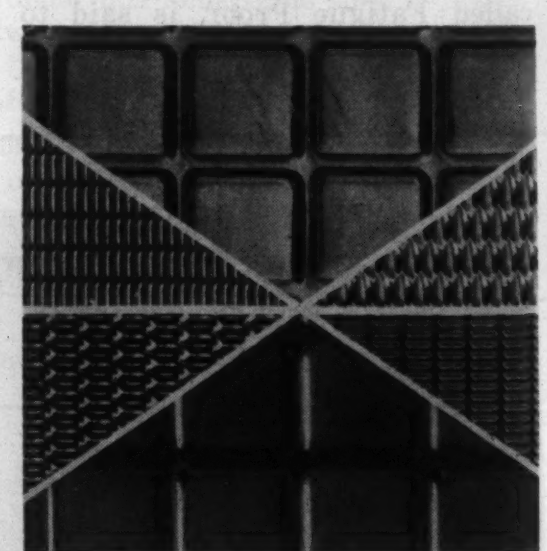
General Plate Div., Metals & Controls Corp., Attleboro, Mass., has developed a tin-clad nickel strip consisting of pure tin solder clad on one side only to pure (type 330) electronic grade nickel. Each layer of the metal is of uniform thickness. The metals are said to be inseparably bonded by a solid phase bonding process without the use of brazing alloys or other intermediate materials.

Used by the transistor industry for germanium cradle supports, the composite metal can be used for tin solder applications requiring close tolerances and layer uniformity.

Available in three standard single-clad ratios—5/95, 10/90 and 20/80—the material is supplied in widths from 0.020 to 3½ in. Overall thicknesses range from 0.005 to 0.015 in.

Six Embossed Patterns Available in Metal Strip

Six embossed metal patterns are now available in all nonferrous and some ferrous alloys from *CroRoto Div., Croname, Inc.*, 3701 N. Ravenswood Ave., Chicago 13, Ill. The patterns are called Wicker Weave, Chain Mail, Block, Grid.



Picturesque, geometric *metal patterns are used for hardware, appliances, automotive trim and lighting fixtures.*

For more information, Circle No. 524 ➤

Stainless Steel TAKES TO WATER
LIKE...

SHARONSTEEL

Stainless Steel

Sharon Stainless Steel takes to water as naturally as a Mallard. It fights off the rust and corrosion effects of water, weather and dampness better than any other metal in general use today. And, its tough, durable finish stays new season after season.

Is it any wonder that more Sharon Stainless Steel is being sold for use on Marine Products this year than ever before?

If yours is a product that must withstand water and dampness, why not consult with a Sharon Metallurgist today.

SHARON STEEL CORPORATION *Sharon, Pennsylvania* DISTRICT SALES OFFICES: CHICAGO, CINCINNATI, CLEVELAND, DAYTON, DETROIT, GRAND RAPIDS, INDIANAPOLIS, LOS ANGELES, MILWAUKEE, NEW YORK, PHILADELPHIA, ROCHESTER, SAN FRANCISCO, SHARON, SEATTLE, MONTREAL, QUE., TORONTO, ONT.

STACKPOLE

CARBON and GRAPHITE SPECIALTIES

Get this helpful booklet! In addition to details on Stackpole products, this 44-page Booklet 40A includes helpful engineering discussions on the physical and electrical properties of carbon and graphite. Copy sent free on letterhead request.

carbon specialties
STACKPOLE

- GRAPHITE TUBE ANODES
- BATTERY CARBONS
- GROUND RODS
- NON-WELDING ELECTRICAL CONTACTS
- VOLTAGE REGULATOR DISCS (carbon piles)
- WATER HEATER and PASTEURIZATION ELECTRODES
- BEARINGS
- WELDING RODS
- WELDING PLATES and PASTE
- RESISTANCE WELDING and BRAZING TIPS
- CHEMICAL CARBON and GRAPHITE (Plain or Treated)
- CARBON RODS FOR SALT BATH RECTIFICATION
- TROLLEY SHOES
- SEAL RINGS
- FRICTION SEGMENTS
- CLUTCH RINGS
- BRAZING FURNACE BOATS
- ELECTRIC FURNACE HEATING ELEMENTS
- MOLDS and DIES
- CONTINUOUS CASTING DIES

STACKPOLE CARBON COMPANY
St. Marys, Pa.

EVERYTHING IN CARBON BUT DIAMONDS

For more information, turn to Reader Service Card, Circle No. 482

Baguette and Roman Brick. They are available in gages ranging from 0.012 to 0.040 in. and are furnished anodized, lacquered, plated and unplated.

Wicker Weave is a pattern of embossed interlocking links and can be used for panels, automotive interiors and exteriors. Chain Mail is a pattern of debossed grooves resembling ancient armor plate and is suitable for hardware, appliances and lighting fixtures. Block and Grid are bold patterns for refrigerators, counter trim, etc.; both patterns can be supplied in widths to 15¾ in. and continuous lengths. Baguette is a continuous pattern of baguette diamond shapes for gift items and small appliances in widths to 16 in. Roman Brick resembles continuous stacks of tiny bricks debossed in the metal and separated by a slender rib; it is available in widths to 16 in. and in continuous lengths.

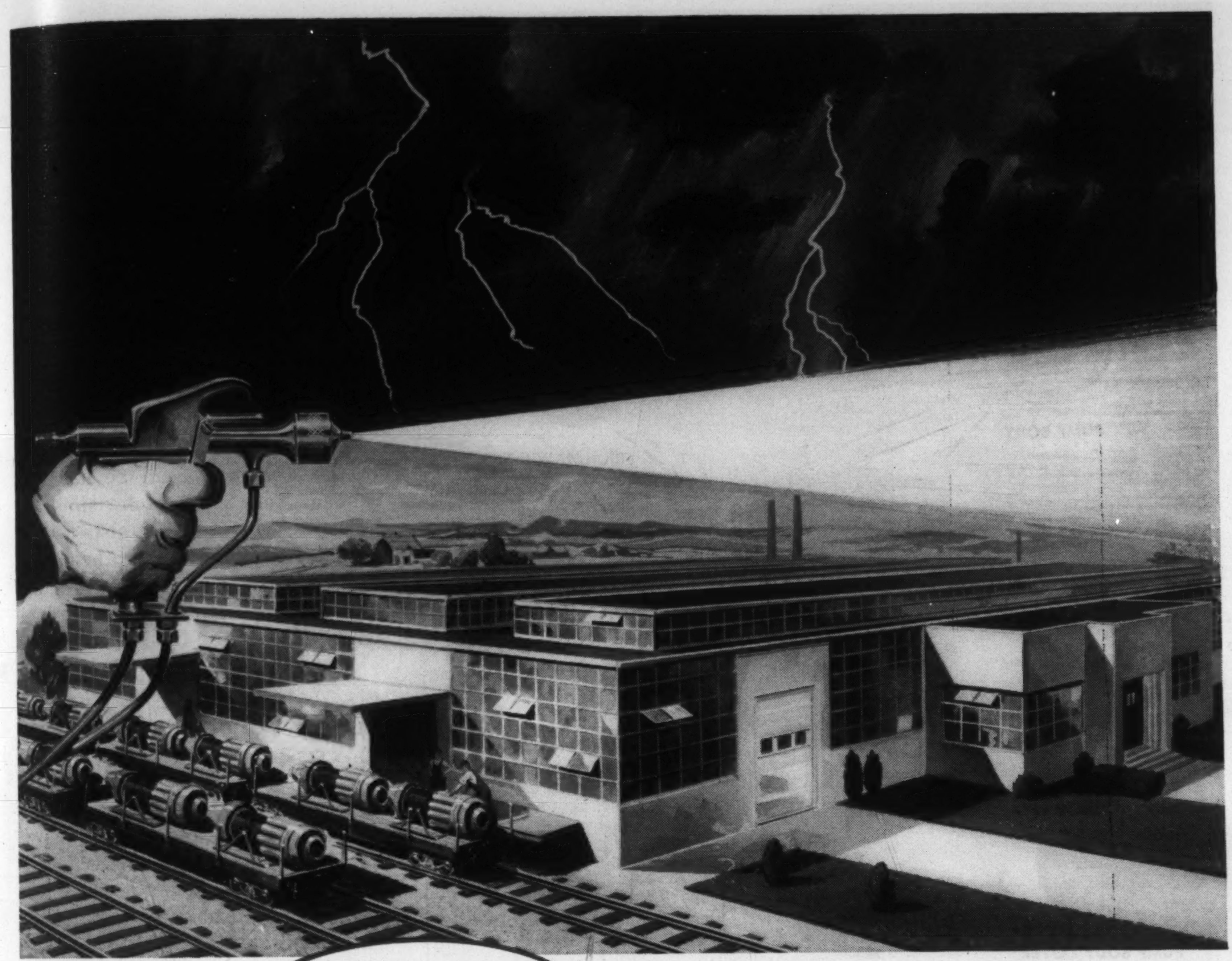
Magnetic Ceramic Saves Critical Metals

A magnetic ceramic material ($BaFe_{12}O_{19}$), produced without such critical materials as cobalt, nickel or other metals, has been

ELECTRICAL PROPERTIES

Elect Res, ohm-cm	$>10^8$
Saturation Magnetic Moment, gauss-cu cm/gm	70
Density (actual), gm/cu cm	4.8 to 4.9
Density (x-ray), gm/cu cm	5.3
Temp Coeff of Induction, per deg F, %	—0.1
Curie Temp, F	842

	Ferroxdure I	Ferroxdure II
Remanence, gauss	2050	3700
Coercive Force, oersted	1500	1200
Intrinsic Coercive Force, oersted	2600	1200
Max Energy Product, (BH) gauss-oersted	0.9×10^6	2.8×10^6
Working Pt B, gauss	1100	2600
Working Pt H, oersted	800	1080



Spray on PROTECTION . . . and wipe out the threat of wear and weather with 6 Exon solution resins

To wipe out corrosion by weather, rust and rot, industry looks to the performance and versatility of the 6 specifically-engineered Firestone Exon solution resins.

Formulated into compounds that can easily be sprayed, brushed, rolled or dipped, these 6 resins cover a variety of needs so diverse that virtually every coating purpose and function is served . . . effectively.

Each of the 6 Exon solution resins is engineered for a specific type of application. It may protect a product, a part, a roomful of machinery or the outside of a plant. Some feature so powerful an adhesive grip that they hold fast for many damage-free years. Others are made to peel off clean in seconds.

All are tough, economical vinyl resins that can help save billions of dollars that management once passed off as "necessary depreciation" due to corrosion. They are a few of the many resins in Firestone's complete line of versatile vinyls. Another reason why industry looks to Exon for engineered answers to its needs.

because they're made of

Firestone

EXON

VERSATILE VINYL RESINS

engineered answers to industry's needs

Firestone Plastics Co. supplies only the resins, does not make the finished solutions.

For complete information or technical service on the entire line of Exon resins, call or write today:

CHEMICAL SALES DIVISION

FIRESTONE PLASTICS CO., DEPT. 73R POTTSTOWN, PA. • A DIVISION OF THE FIRESTONE TIRE & RUBBER CO.

For more information, turn to Reader Service Card, Circle No. 440

PRODUCT DESIGN WITH DUREZ PHENOLICS

WESTINGHOUSE
makes sure 8 ways...

PUMP BODY
MOTOR PULLEY SLIDE
FRICTION WHEEL
CONDENSER HOUSING
LINT CATCHER
PUMP BODY COVER
PUMP BODY
WATER INLET VALVE

with Laundromat* parts of DUREZ phenolics

Probably no single group of plastics offers design engineers such wide latitude in meeting specific service conditions as the Durez phenolics. These eight components now helping to implement the slogan "You can be sure if it's Westinghouse" are a notable example.

The problem was to create long-wearing, non-corrosive, economical parts of light weight for new Laundromats. All these objectives were achieved by replacing metal with parts molded of *four different* Durez materials. Working as a team, Westinghouse engineers and the molder, General Industries Co., selected each of the four Durez phenolics for better performance at lower manufacturing cost on the job it must do.

To save time in capitalizing on the versatility of Durez, talk over your design problems first with your molder. Or call on our Technical Field Service in putting its mechanical, electrical, and chemical properties to profitable use.

DUREZ®
Phenolic Plastics that fit the job

DUREZ PLASTICS DIVISION
HOOKER ELECTROCHEMICAL COMPANY
1412 Walck Road, North Tonawanda, N. Y.

HOOKER
CHEMICALS
PLASTICS

*Laundromat ® by Westinghouse Electric Corp

For more information, turn to Reader Service Card, Circle No. 409

announced by *North American Philips Co., Inc.*, 750 S. Fulton Ave., Mt. Vernon, N.Y.

Called Ferroxdure, it is unaffected by external fields and is reported to be practically impossible to demagnetize once it has been polarized. Compared with metal magnets, it is smaller in size and lighter in weight. The sintered material can be used in loudspeakers and in television for focusing yokes. It is also useful for refrigerator and cabinet door latches, motors and generators, oil filters and rotating mechanical couplings.

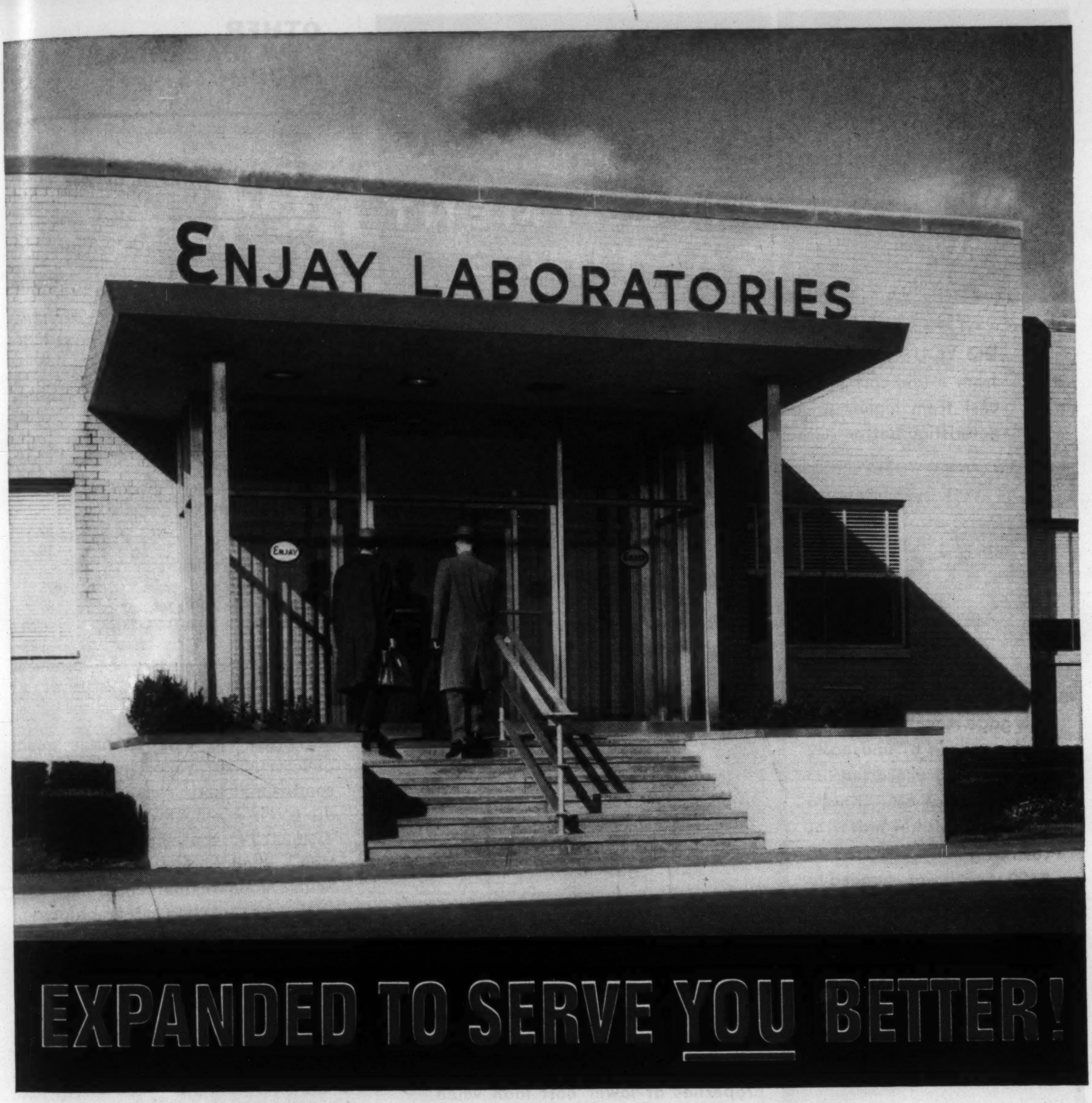
Nylon Powders for Sintered Parts

A formulation of finely divided nylon powders, termed Nylasint 64, is reported to be much tougher in the cold pressed and sintered form than sintered nylons presently available. Developed by *National Polymer Products, Inc.*, Reading, Pa., the material finds use in the forming of mechanical parts by cold pressing and oil sintering, somewhat similar to techniques used in powder metallurgy. Inert fillers as molybdenum disulfide and graphite provide specific advantages to the finished part.

The new formulation can be used for forming gears, bearings, rollers, bushings, cams and similar wear parts.

Two Fire Resistant Electrical Laminates

Two arc resistant laminates have recently been announced by *National Vulcanized Fibre Co.*, 1056 Beech St., Wilmington 99, Del. One laminate, called GP-9204, is a polyester resin-glass mat laminate that has Underwriters' Laboratory approval as a flame resistant material. It is approved for the sole support of current carrying parts at tempera-



The Enjay Company proudly invites you to inspect the new polymer wing of the Enjay Laboratories, located in Linden, N. J. Continuing the tradition of pioneering in petrochemicals, Enjay has built this new laboratory addition for application research and development exclusively in the polymer division.

With the latest technical equipment and top scientific talent, this new laboratory enables the Enjay Company to give the best possible product application service, as well as furthering Enjay's own product research program.

High speed electronic data processing equipment helps the Enjay scientists solve your compounding problems in record time. In developing new products, or improving old ones, call on Enjay for top-notch assistance. Contact your Enjay representative for further information.

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BUTYL

Enjay Butyl is the super-durable rubber with *outstanding* resistance to aging • abrasion • tear • chipping • cracking • ozone and corona • chemicals • gases • heat • cold • sunlight • moisture.

Pioneer in Petrochemicals

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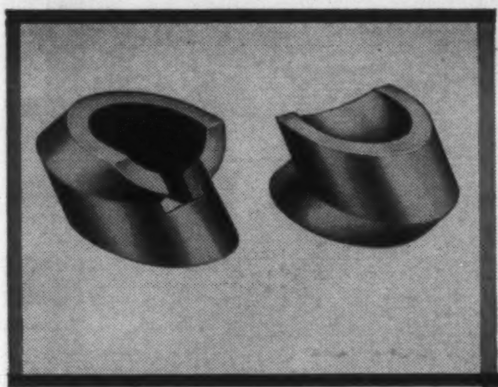
For more information, turn to Reader Service Card, Circle No. 374

Basic Considerations in Selecting alloys . . . . . for your

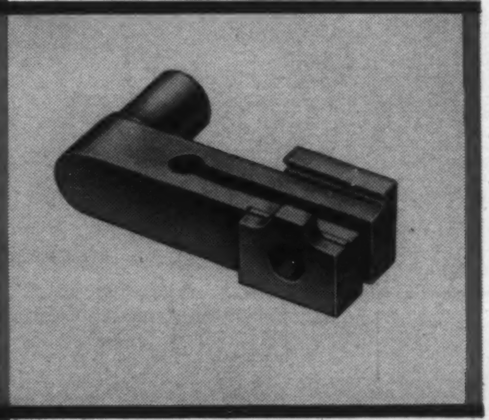
INVESTMENT CASTINGS

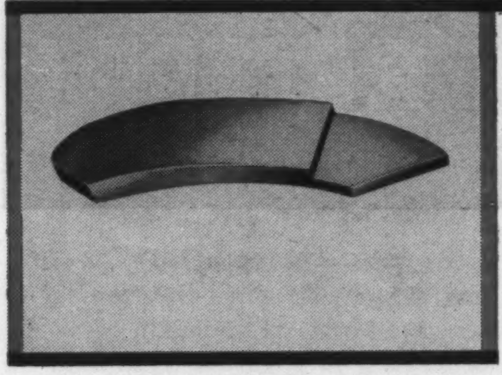
DO YOU KNOW THAT . . . an investment casting produced from a low cost metal may be MORE EXPENSIVE than one cast from higher priced material that may also have characteristics better suited to your requirements.



These angle connectors were originally investment cast in mild steel, a low cost material. To overcome corrosion problems, 303 stainless was substituted and because of its better castibility there was no increase in cost. Now, silicon brass is being used at a 10% saving on the original selling price.

This gage mount is an excellent example of unusually good casting characteristics of one metal offsetting a decidedly higher material cost. Originally priced in SAE 8620 steel, it was changed to beryllium copper at a 15% saving in unit price.





This simple textile machine part requires a high degree of wear resistance. Casting in the right metal provided better properties at lower cost than when machined from tool steel.

Get more complete information for this is only a small part of the story telling how the right metal selection for investment castings can often increase efficiency and reduce costs.

WRITE today for Bulletin 116-205 . . . it's FREE!

HITCHINER
Manufacturing Company
MILFORD 7, NEW HAMPSHIRE
REPRESENTATIVES IN PRINCIPAL CITIES

For more information, turn to Reader Service Card, Circle No. 363

OTHER NEW MATERIALS PRODUCTS

PROPERTIES OF GP-9204
(⅛ in. thick)

Flex Str (cond A), psi:	
Machine Direction	31,800
Cross Direction	26,200
Impact Str (cond E-48/50), ft-lb/in.:	
Machine Direction	12.6
Cross Direction	10.9
Rockwell M Hardness (73 F)	98
Dissip Factor (10^6 cycles):	
Cond A	0.011
Cond D-24/23	0.043
Dielec Const (10^6 cycles):	
Cond A	4.37
Cond D-24/23	4.82
Dielec Str (par. to lam, step-by-step), kv:	
Cond A	52.5
Cond D-48/50	10.2
Dielec Str (perp to lam, cond A), v/mil	425
Arc Resistance (cond A), sec	180
Water Absorption (cond D-24/23), %	0.40
Density	1.79

tures up to 300 F.

GP-9204 is said to have good dielectric loss properties under dry conditions and reasonably good dielectric strength under wet conditions. The material has, in addition, good resistance to most acids; good resistance to solvents such as carbon tetrachloride, toluene, gasoline and ethyl alcohol; and fair resistance to weak alkalies. Grade GP-9204 comes in three sheet sizes (32 x 36, 32 x 48 and 32 x 74 in.) and is recommended for panels, cams, armature slot wedges, spacers, switchboard panels, switch insulators and arc chutes.

The other laminate, called Phenolite Y-2500, is a paper-base laminate bonded with a modified phenolic resin that gives fire resistant qualities for electrical and electronic applications. Phenolite Y-2500 passes the standard Underwriters' Laboratory flame test and is self-extinguishing within 5 sec after the application of a flame for 10 sec.

The paper-base laminate is said to punch and shave better than other melamine paper-base laminates presently used for arc resistant applications.

Phenolite Y-2500 provides an arc resistance of 100 sec and is

FOR HIRE...world's largest press for molding reinforced plastics

This new 1,000 ton-press is ready to work for you. It's especially designed for reinforced plastics, with an 8′ x 16′ platen. It molds parts up to 3-feet high. **It can accommodate molds for large single-piece parts, such as boat hulls, over 16′ long.**

One-piece doors, door frames, automobile fiberglass body sections, book cases, desks, wall panels . . . in fact, whatever your plastics molding product, this press is at your service.

General American Transportation Corporation, Plastics Division, invites inquiries as to time and tonnage schedules and detailed production information. Write or call:

The largest press of its kind ever built. This massive reinforced plastics press weighs over 170 tons. It's more than 2 stories above floor level with an additional 1½ stories in the foundation.

PLASTICS DIVISION
GENERAL AMERICAN TRANSPORTATION CORPORATION
135 South La Salle Street, Chicago 90, Illinois

Facilities unmatched anywhere: injection, compression, extruding, and vacuum forming, reinforced plastics, painting and assembling

For more information, turn to Reader Service Card, Circle No. 546

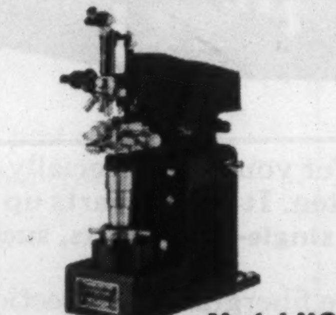
ACCO products

Wilson "Tukon"
Micro Hardness Testers

UNEXCELLED
for testing
fine parts...
METALLIC and
NON-METALLIC

Model LR
Floor model for Micro and Macro Hardness Testing.

Model FB
Floor model for Micro Hardness Testing only. (Electrically operated)



Model MO
Table model for Micro Hardness Testing only. (Mechanically operated. Also available in floor model)

WILSON "TUKON" Micro Hardness Testers meet every fine test requirement. These precision instruments are invaluable in the proper testing of fine precision parts, fine wire, thin metal, shallow superficially hardened surfaces, jewels, plastics, glass, etc. WILSON "TUKON" testers operate with both Knoop and 136 degree Diamond Pyramid Indenters.

Consult with WILSON Engineers on your hardness testing problem

Experienced WILSON Engineers will be glad to help you select the proper model for your particular requirement. This choice depends on the type and thickness of work to be tested, range of loads and other hardness testing equipment available.

Write for Booklet **DH-328** *on WILSON "TUKON" Micro Hardness Testers. Ask for* **DH-325** *on WILSON "ROCKWELL" Hardness Testers.*

WILSON "ROCKWELL"...
the world's standard of hardness accuracy

for Better Value

ACCO
Wilson Mechanical Instrument Division
AMERICAN CHAIN & CABLE
230-E Park Avenue, New York 17, N. Y.

For more information, turn to Reader Service Card, Circle No. 494

recommended for arc deflectors, circuit breaker components, electrical switches and other interrupting devices. It is supplied in standard semigloss and a special dull finish in either natural (light brown) or red, and is available in sheet sizes of 39 x 47 and 39 x 39 in., and in thicknesses from 0.015 to 1 in.

Ceramic Magnets Increased in Power

Several improvements in Indox I ceramic permanent magnets have been announced by *Indiana Steel Products Co.*, Valparaiso, Ind. They include an increase in residual induction from approximately 2000 gauss to approximately 2100 gauss; an increase in coercive force from 1600 to approximately 1700 oersteds; and an increase in peak energy product (BH max) from 0.8 x 10^6 to 0.95 x 10^6. The improvements are said to make it possible to use smaller magnets for a given job.

The magnets are nonconductors and are hard, brittle and much lighter in weight than magnets made of metallic alloys. No critical materials are used in the manufacture of Indox I, and they can be magnetized prior to assembly.

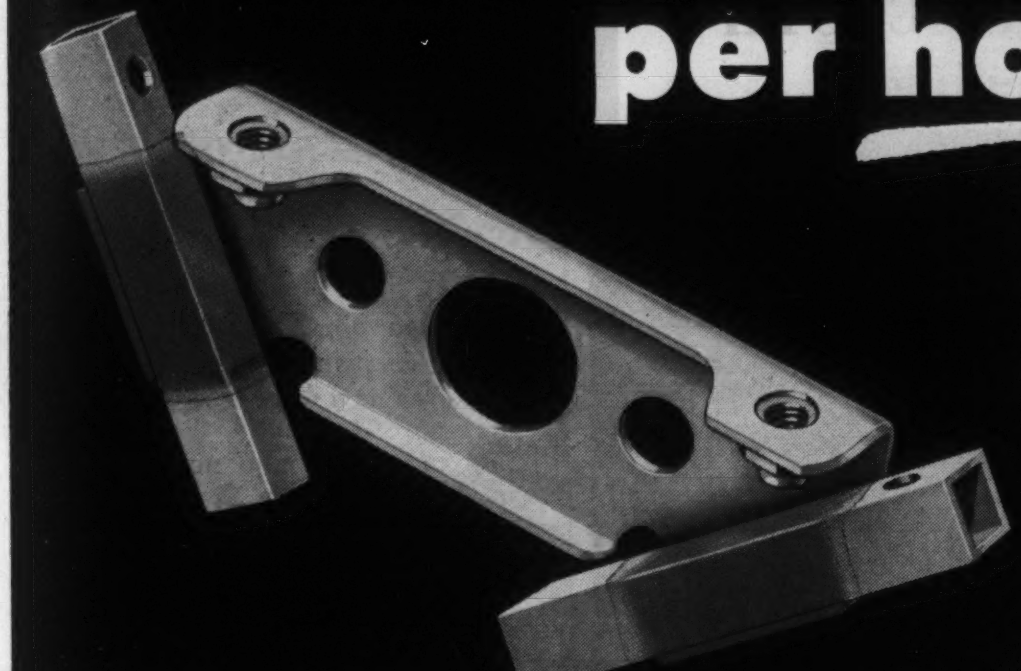
The magnets may be used for TV focusers, traveling wave tubes, loudspeakers, synchronous drives, cabinet latches, can openers, door closers, conveyors, toys and novelties.

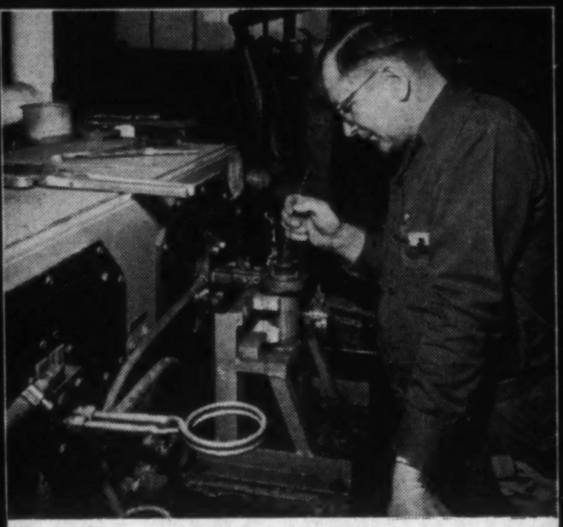
Strong Adhesive Film for Irregular Parts

A pressure sensitive film developed by *Angier Adhesives Div., Interchemical Corp.*, 120 Potter St., Cambridge 42, Mass., is said to have high strength properties because of a special tissue reinforcement.

Designated Double Face, the adhesive film is adaptable to a vari-

JACK & HEINTZ Saves $15.84 per hour...





Jack & Heintz Inc. silver brazes over 25 different parts on this 15 KW, 10,000 cycle TOCCO machine.

with TOCCO* Induction Brazing

Brazing Costs Down

When Jack & Heintz engineers switched from torch brazing to automatic induction, brazing cost of these inverter brush mounts fell from $.05 to $.006 each —a reduction of 83% in direct labor costs alone! Additional savings result because less cleaning is required after TOCCO, and fuel costs are much lower, too.

Brazing Production Up

While costs dropped, production on the part zoomed —from 40 to 360 brazed assemblies per hour. Furthermore, rejects and scrap, formerly high, are now negligible.

Versatility

The part shown is just one of over 25 parts, large and small, which alert J & H engineers have converted from old-fashioned brazing methods to modern, automatic TOCCO. Overall brazing costs (TOCCO brazing versus former methods used) are down 75%—brazing speed, up 100%.

* * *

If the manufacture of *your* product involves brazing, heat-treating, forging or melting of ferrous or nonferrous metals, don't overlook TOCCO as a sound method of increasing production, improving product quality and slashing costs.

THE OHIO CRANKSHAFT COMPANY

JUST PUSH A BUTTON
TOCCO

*Trade Mark Reg. U.S. Pat. Off.

Mail Coupon Today

NEW FREE BULLETIN

THE OHIO CRANKSHAFT CO.
Dept. T-12, Cleveland 5, Ohio

Please send copy of "Typical Results of TOCCO Induction Brazing and Soldering".

Name__________
Position__________
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City______ Zone____ State____

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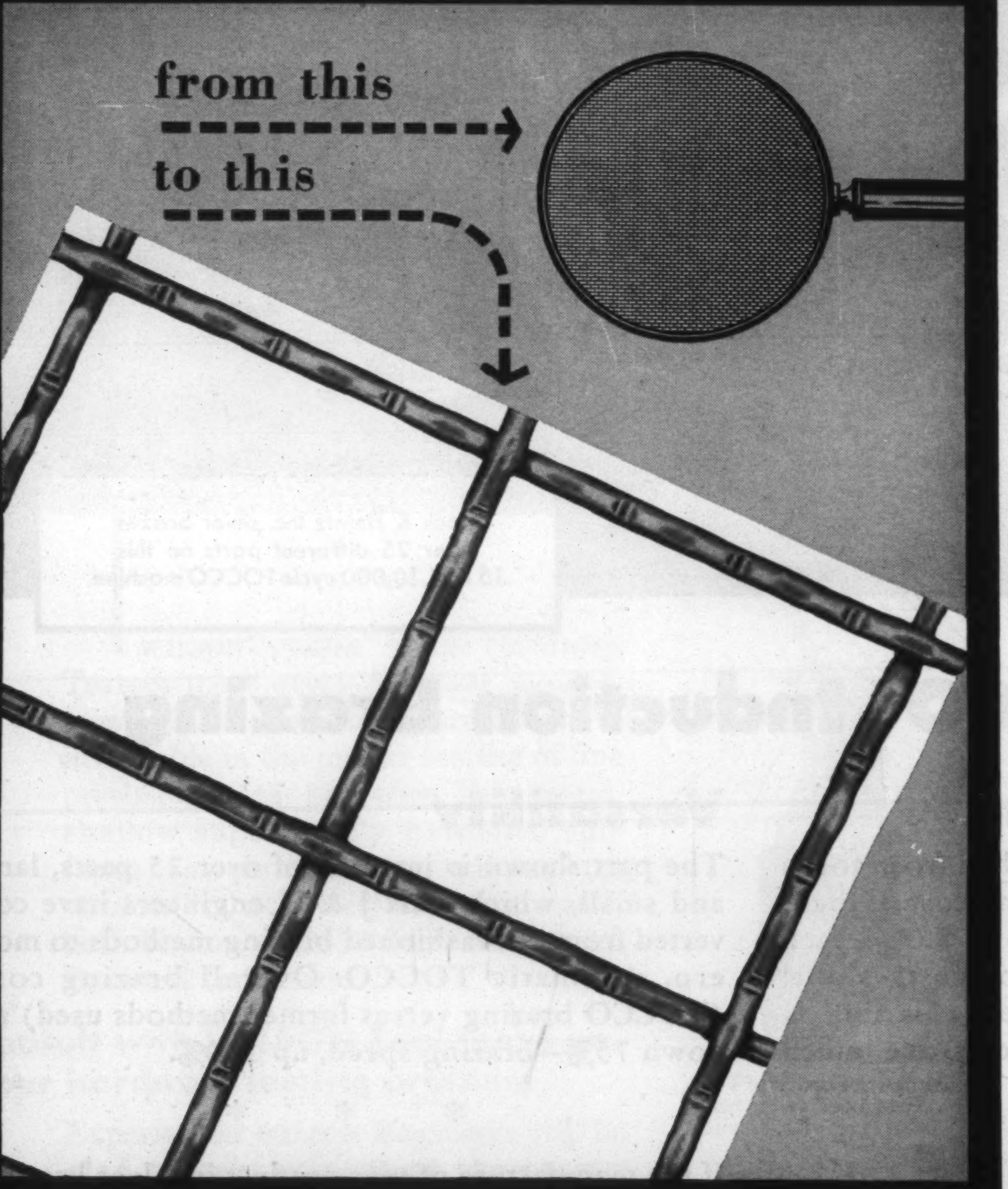
Call Cambridge

for prompt service and delivery on
INDUSTRIAL WIRE CLOTH
with mesh openings



in 9 weaves
in any metal or alloy
in bulk or
fabricated parts

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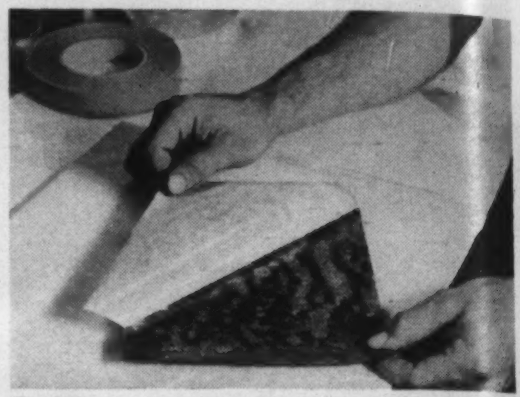
LET US FILL your next order for wire cloth in any mesh or weave. Call your Cambridge Field Engineer—he's listed under "Wire Cloth" in your classified telephone book. OR, WRITE DIRECT for FREE 80-PAGE CATALOG and stock list giving full range of wire cloth available. Describes fabrication facilities and gives useful metallurgical data.

For more information, turn to Reader Service Card, Circle No. 427



Release paper *can be removed at once for instant bonding or can be removed at a later date by consumer.*

ety of porous and nonporous materials. Said to be a substitute for liquid adhesives and mechanical fastenings, it easily conforms to highly irregular surfaces.

The film is supported by a double-coated release paper which can be removed at once for instant bonding, or can be removed at a later date. It can be slit or die cut with the protective release paper in place.

It is supplied soft, medium and firm in rolls 72 yd long having widths from 1/8 to 39 in.

Low Cost Insulation for Class B Uses

A low cost, flexible, glass mat-polyester insulation has been announced by *Glastic Corp.*, 4321 Glenridge Rd., Cleveland 21, Ohio. Called Grade FM, the material is suitable for bending around corners or for wrapping cylindrical forms. It is available in standard thicknesses of 1/32, 3/64 and 1/16 in. in 36 x 72-in. sheets.

The glass mat-polyester insulation is reported to be heavy enough to give substantial mechanical support, and flexible enough (in 1/32 in. thickness) to bend to a 3-in. dia without loss in dielectric strength. It also said to offer good dimensional stability and low moisture absorption after prolonged heat exposure, and it can withstand continuous exposure to Class B temperatures (266 F) without loss in dielectric strength.

The low cost insulation is said

For more information, Circle No. 367 ➤

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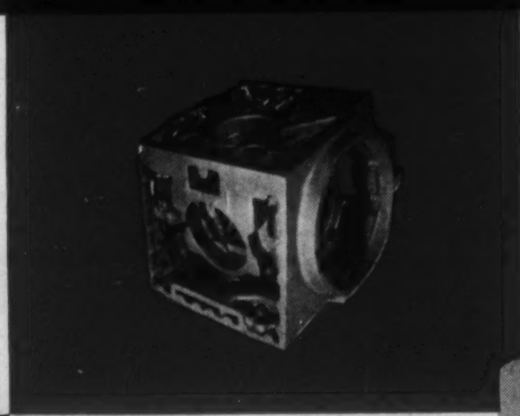
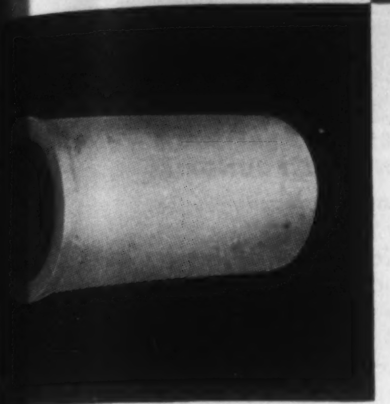


Intricate Castings
CWC metallurgical engineering, control and mechanization provide the means to produce castings of the most intricate design.

Heat-Treated Castings
Heat-treating facilities range from small batch type furnaces through continuous quench and temper furnaces to meet modern casting requirements.

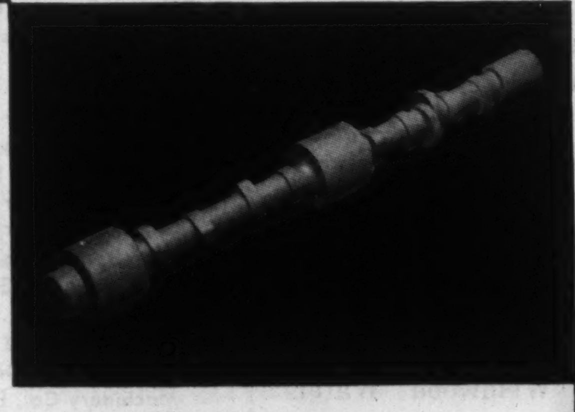


CAMPBELL · WYANT · CANNON
FOUNDRY CO.

Here's how CWC meets grey iron, iron alloy and steel casting needs!

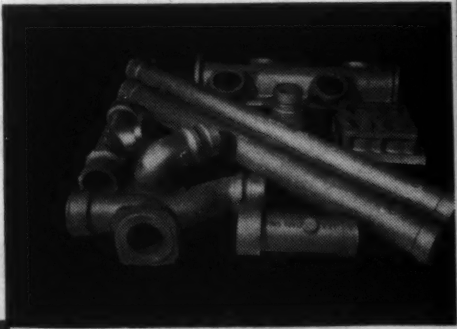
Six Campbell, Wyant and Cannon foundries, located in the heart of the Great Lakes industrial area, are fully equipped to produce the castings you need. Superior quality is maintained through exacting inspection and testing methods. Complete mechanization assures volume production at low cost and delivery on schedule. Look to CWC research engineering and facilities as your source for iron and steel castings. Write today . . . get your copy of the "One Source" booklet. It tells why CWC is the best source for many different casting requirements!

Steel Castings
CWC's extensive facilities make possible the production of over 150 tons of steel castings a day.



Castings With Special Properties
CWC's development of special purpose electric alloy irons for greater strength and resistance to wear, heat and corrosion helps cut machining time and costs.

General Purpose Castings
A large variety of general purpose castings are produced in the CWC foundries.



campbell
wyant and
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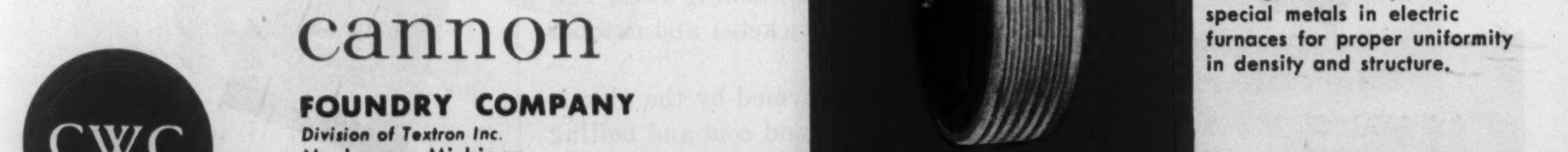
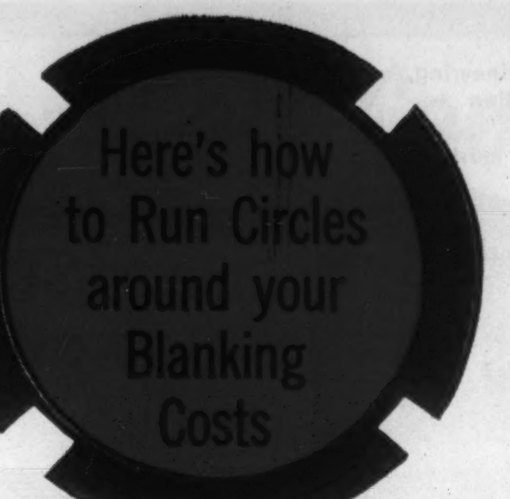
FOUNDRY COMPANY
Division of Textron Inc.
Muskegon, Michigan

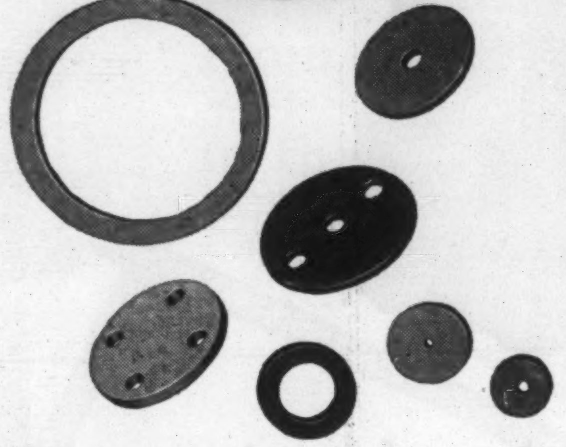
CWC

Centrifugal Castings
A pioneer in centrifugal casting, CWC alloys its own special metals in electric furnaces for proper uniformity in density and structure.



SIX FOUNDRIES LOCATED IN MUSKEGON, LANSING AND SOUTH HAVEN, MICHIGAN . . . READY TO SERVE YOU



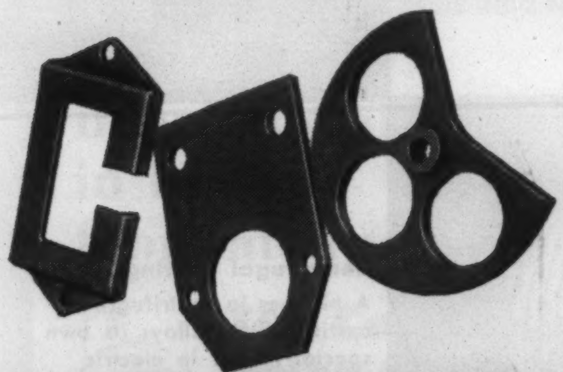


From washers to sprockets; from cams to gears—*steel plate blanks* supply the ideal base for a host of circular parts . . . And for special shapes, too.

Speaking of circles (discs, rings, bosses, sprocket blanks, plates) you can figure we save you time, and die and machinery costs, with our stock dies—*almost every fractional diameter up to 26½ inches!*

And for parts that must be "out of round"—special shapes to your design—you can bank on faithfulness to drawings, close tolerances and absolute flatness.

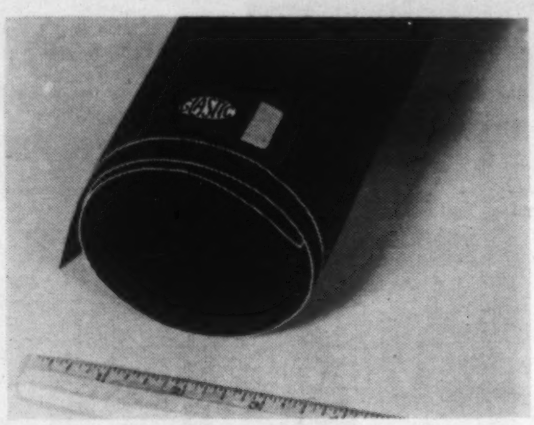
Press capacity for steel plate 3/16" to 1¼" thick. Machining and heat treating operations available. Large inventory in mild and high carbon steel. Custom service at prices you'll applaud. Let's get together. Write, phone or wire!



Cleveland Pressed Products Corporation
6714 Union Ave., Cleveland 5, Ohio
VUlcan 3-7900

For more information, Circle No. 438

OTHER NEW MATERIALS PRODUCTS



***Glass mat-polyester** insulation can be bent to a 3-in. dia without loss in dielectric strength.*

to offer flexible Class B insulation users savings in both material and labor costs because less wraps are needed due to the greater thickness available in the material.

The insulation finds use for motor and generator phase insulation, transformer core wrapping, curved barriers for switchgear, and other applications where flexible Class B insulation is required.

Adhesives for Foams, Wood, Other Materials

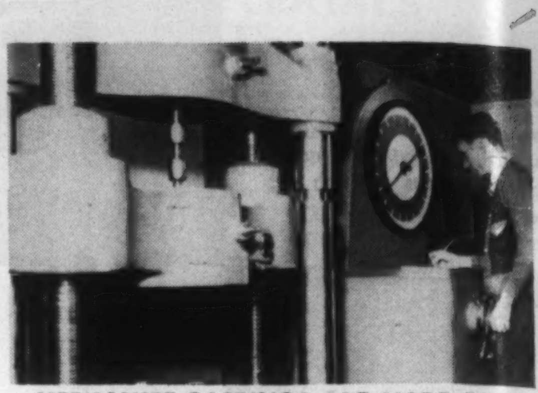
Recent developments in adhesives include specialized materials for vinyl foam and polystyrene foam, a waterproof adhesive for wood and an entire new line of assembly line adhesives.

1. Waterproof wood adhesive

An adhesive that is said to be absolutely waterproof has been developed by the *United States Plywood Corp.*, Weldwood Bldg., 55 W. 44th St., New York 36, N.Y.

Known as Weldwood Waterproof Resorcinol Glue, the material is said to meet government specifications for marine and aircraft work. It may be safely used for a permanent bond on boats, sporting goods (fishing rods, golf clubs, tennis rackets) and outdoor furniture.

The bond formed by the glue is said to withstand cold and boiling water, tropical heat, sub-freezing temperatures, mild acids, alkalies, steam, mold, fungus, solvents and continuous outdoor exposure to



MEEHANITE CASTINGS ARE MADE ONLY BY MEEHANITE FOUNDRIES

The American Laundry Machinery Co., Rochester, N. Y.
Atlas Foundry Co., Detroit, Mich.
Banner Iron Works, St. Louis, Mo.
Barnett Foundry & Machine Co., Irvington and Dover, N. J.
Centrifugally Cast Products Div., The Shenango Furnace Co., Dover, Ohio
Blackmer Pump Co., Grand Rapids, Mich.
Compton Foundry, Compton, Calif.
Continental Gin Co., Birmingham, Ala.
The Cooper-Bessemer Corp., Mt. Vernon, Ohio and Grove City, Pa.
Crawford & Doherty Foundry Co., Portland, Ore.
DeLaval Steam Turbine Co., Trenton, N. J.
Empire Pattern & Foundry Co., Tulsa, Okla.
Florence Pipe Foundry & Machine Co., Florence, N. J.
Fulton Foundry & Machines Co., Inc., Cleveland, Ohio
General Foundry & Mfg. Co., Flint, Mich.
Georgia Iron Works, Augusta, Ga.
Greenlee Foundry Co., Chicago, Ill.
The Hamilton Foundry & Machine Co., Hamilton, Ohio
Hardinge Company, Inc., New York, N. Y.
Hardinge Manufacturing Co., York, Pa.
Johnstone Foundries, Inc., Grove City, Pa.
Kanawha Manufacturing Co., Charleston, W. Va.
Kennedy Van Saun Mfg. & Eng. Corp., Danville, Pa.
Koehring Co., Milwaukee, Wis.
Lincoln Foundry Corp., Los Angeles, Calif.
Mattison Machine Works, Rockford, Ill.
Palmyra Foundry Co., Inc., Palmyra, N. J.
The Henry Perkins Co., Bridgewater, Mass.
Pohlman Foundry Co., Inc., Buffalo, N. Y.
Rosedale Foundry & Machine Co., Pittsburgh, Pa.
Ross-Meehan Foundries, Chattanooga, Tenn.
Sonith Industries, Inc., Indianapolis, Ind.
Standard Foundry Co., Worcester, Mass.
The Stearns-Roger Mfg. Co., Denver, Colo.
Valley Iron Works, Inc., St. Paul, Minn.
Vulcan Foundry Co., Oakland, Calif.
Washington Iron Works, Seattle, Wash.
Dorr-Oliver-Long, Ltd., Orillia, Ontario
Hartley Foundry Div., London Concrete Machinery Co., Ltd., Brantford, Ontario
Otis Elevator Co., Ltd., Hamilton, Ontario

MEEHANITE CASTINGS

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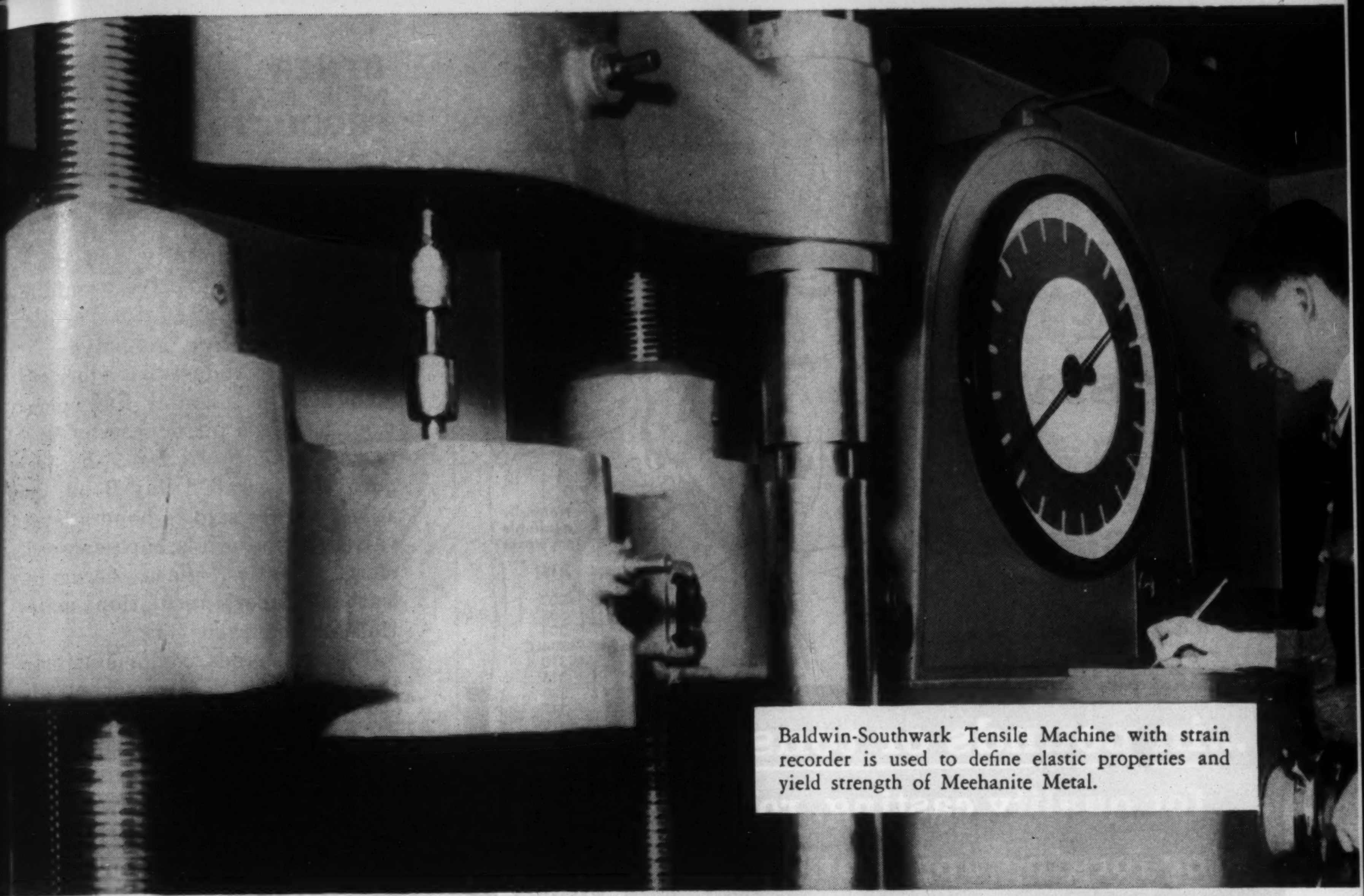
• **"MEEHANITE CASTINGS FOR PRESSURE TIGHTNESS" BULLETIN NO. 43**

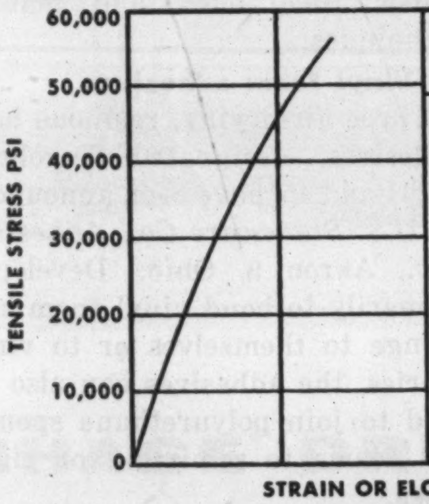
MEEHANITE®

For more information, Circle No. 518



Baldwin-Southwark Tensile Machine with strain recorder is used to define elastic properties and yield strength of Meehanite Metal.

MEEHANITE CASTINGS POSSESS TRUE ELASTIC PROPERTIES AND ARE MADE TO RIGID ENGINEERING SPECIFICATIONS

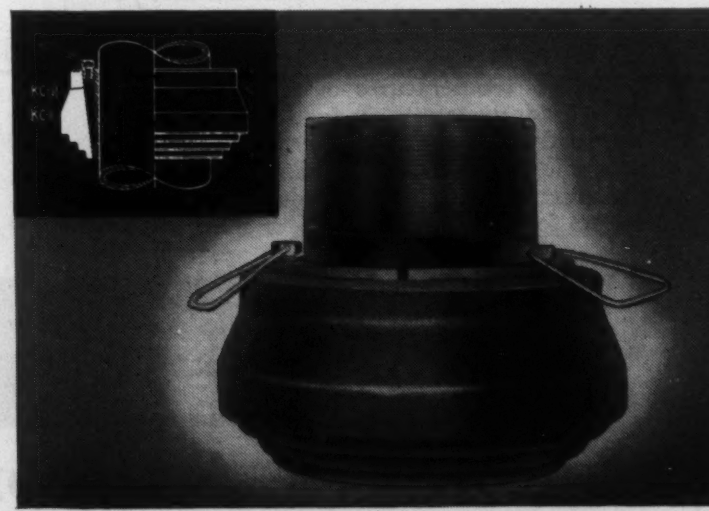


MEEHANITE METAL TYPE GA AS CAST
PROPORTIONAL LIMIT 21,000 PSI
TENSILE STRENGTH 55,000 PSI
BRINELL HARDNESS 227 BHN
MODULUS ELASTICITY 20,000,000

Meehanite Metal has a controlled microstructure, consisting of uniformly distributed graphite in a fully pearlitic matrix, which is comparable to that of a normalized spring or tool steel. This structure, the result of a unique manufacturing process based upon proven metallurgical techniques, assures good tensile properties in association with high yield strength and elastic modulus. These properties are of paramount importance in the selection of engineering materials since they aid in defining the useful characteristics of Meehanite Metal in service.

For information, write today for Bulletin 43—Meehanite Castings for Pressure Tightness.

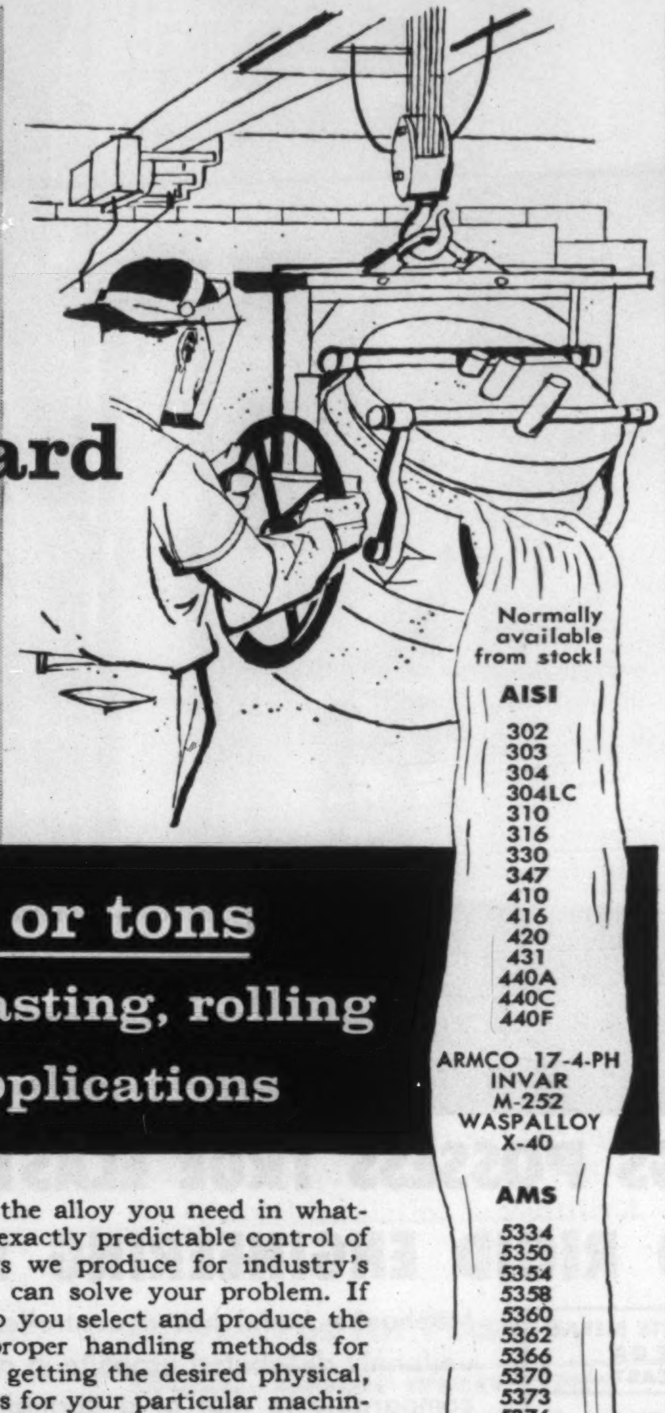
Power-Twin hydraulic pullers of 17½, 30 and 50 ton capacities manufactured with Meehanite ram body castings tested to 24,000 psi. The 30-ton unit needed an applied load of 87 tons before failure.



Meehanite casting support (KC-1) to hold tapered slips (KC-2) is subjected to downward pressures of up to 150,000 lbs. in oil well drilling. No evidence of failure under loads up to 210,000 lbs.

Call Cannon-Muskegon for standard and custom alloys

...in pounds or tons
for quality casting, rolling or forging applications



Normally available from stock!

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304
304LC
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440A
440C
440F

ARMCO 17-4-PH
INVAR
M-252
WASPALLOY
X-40

AMS
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SAE
"II" B-2
"II" D-2
M-2
T-1
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4145
4620
52100
6150
8620

PWA651
PWA787M
*NI-RESIST 1A
*INCONEL
*MONEL
4750
WAD 8338
WAD 8370

*®International Nickel Co.

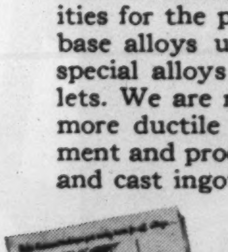
Cannon-Muskegon can provide the alloy you need in whatever amount you want . . . with exactly predictable control of characteristics. Check the alloys we produce for industry's special needs . . . one or several can solve your problem. If not, Cannon-Muskegon can help you select and produce the right material . . . recommend proper handling methods for best results. You can be sure of getting the desired physical, chemical and electrical properties for your particular machining or processing operation. And remember — Cannon-Muskegon *certifies* specifications of its MasterMet alloys.

Test or production lots available

We are equipped to supply you with sample or production quantities. There's a wide choice of carbon and 300 and 400 series stainless steels available from stock for immediate delivery. Preparation of special alloys begins immediately on receipt of your order. Alloys are available in shot, ingot, billet or cast bars.

Now... UltraMet vacuum melted alloys

Cannon-Muskegon announces vacuum melting facilities for the production of iron-, nickel- and cobalt-base alloys up to temperatures of 3100°F . . . and special alloys for industry . . . in ingots or cast billets. We are ready to provide cleaner, stronger and more ductile alloys for remelt . . . sample development and production of vacuum process castings . . . and cast ingots for forging, extruding or machining.



Write for your copy of New MasterMet Bulletin and technical data on the complete MasterMet alloy service.

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CANNON-MUSKEGON
CORPORATION
2873 Lincoln Street Muskegon, Michigan
METALLURGICAL SPECIALISTS

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OTHER NEW MATERIALS PRODUCTS

rain, snow, humidity and other elements. The adhesive is said to have an indefinite storage life.

2. Assembly line adhesives

A line of industrial adhesives adaptable to assembly line operations has been introduced by *Raybestos-Manhattan, Inc.,* Bridgeport, Conn. Called Ray-Bond, the adhesives are said to bond a large variety of materials, such as wood, metal, plastics, glass, ceramics, leather, paper, insulation materials, rubber and cork.

The compounds, comprising both thermosetting and thermoplastic types, are based on synthetic and natural rubber, resin bases of all types and combinations of rubbers and resins. They are said to withstand temperatures ranging from —80 to 700 F. The adhesives are also claimed to offer good resistance to most oils, solvents, gasoline and water.

Adhesives are available for application by spray, pressure flow, brush, roller coat and manual techniques.

3. Vinyl foam adhesives

Three air-drying, resinous base adhesives, designated Tygobond 40, 41 and 45, have been announced by *U.S. Stoneware Co., Adhesives Div.,* Akron 9, Ohio. Developed primarily to bond vinyl foam and sponge to themselves or to vinyl fabrics, the adhesives can also be used to join polyurethane sponge and foams to semirigid or rigid bases.

The nonstaining, fast tack adhesives are said to require only contact pressure, without heat curing, to produce an exceptionally strong, clear bond that is resistant to water, acids, alkalies, oils, and certain solvents. The solvent used in the adhesives does not destroy the cell structure of the foam.

Tygobond 40 is formulated for spray application. Tygobond 40, 41 and 45 are easily applied by brush or machine coating.

The adhesives can also be used for bonding thermoplastic sheet and film, leather, paper, metal foil,

When finish is important...
RIGHT FROM THE START!

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What an amazing timesaver! Wonderfully smooth Chase Dry-Rolled strip forms as quickly and easily as ordinary quarter or half-hard strip. Yet, parts are so mirror-bright that regular buffing operations can be *slashed*—sometimes even eliminated!

Chase Dry-Rolled brass or copper strip is actually burnished at the mill, by super-smooth rolls. It's a special finishing process that can be applied to many of the Chase alloys you regularly use.

No extra charge for Chase Dry-Rolled strip! That's why it'll pay you to call in a Chase representative to talk over the use of this cost-cutting metal. Call today!

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Buildings of Today and Tomorrow...

Protected With
SPRAYLAT Strippable Coatings!

Now... window frames, polished or painted metal doors, door bucks, ornamental metal, tile and marble units, and other component parts for new buildings are being protected with SPRAYLAT* and COVERLAC* Strippable Coatings.

The various products are spray coated by the manufacturer in his plant, for protection during fabrication, shipment, installation and construction. When the building is completed, SPRAYLAT'S tough, pliable coatings are easily "peeled off" leaving surfaces factory-fresh... free from foreign material, scratches and other injuries. Hours of costly refinishing are thereby avoided.

From start to finish... in every phase of manufacture... whether the surface is enamel, lacquer, metal, plastic, glass or marble, SPRAYLAT CORPORATION has a specialized compound for every requirement.

Remember... it is cheaper to protect than to refinish.

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felt or textiles to ceramics, wood, metal or composition bases.

4. Styrofoam adhesive

Adhesive Products Corp., 1660 Boone Ave., New York 60, N.Y., has introduced an adhesive called No. 145-0 Styrogrip for bonding Styrofoam to plywood, galvanized iron, concrete block and other materials.

It is a colorless resin solvent adhesive that is claimed to have excellent water resistance. The solvent in the quick drying material does not attack Styrofoam.

5. Contact adhesive

A contact adhesive, called Pliotac, has been developed by *Goodyear Tire & Rubber Co., Chemical Div., Coatings Dept.*, Akron, Ohio. Said to remain permanently flexible after application, the light colored material also has good color retention and good water and moisture resistance.

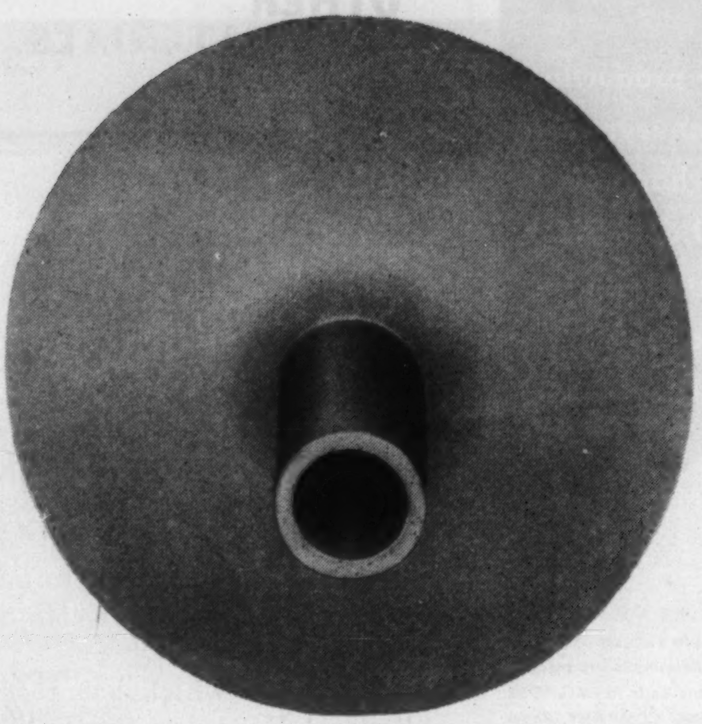
Containing 25% solids, the adhesive is recommended for joining any combination of plywood, plastic, fiberglass, foam rubber, natural fiber textiles, metals, plaster, concrete and ceramics, especially where large areas are involved.

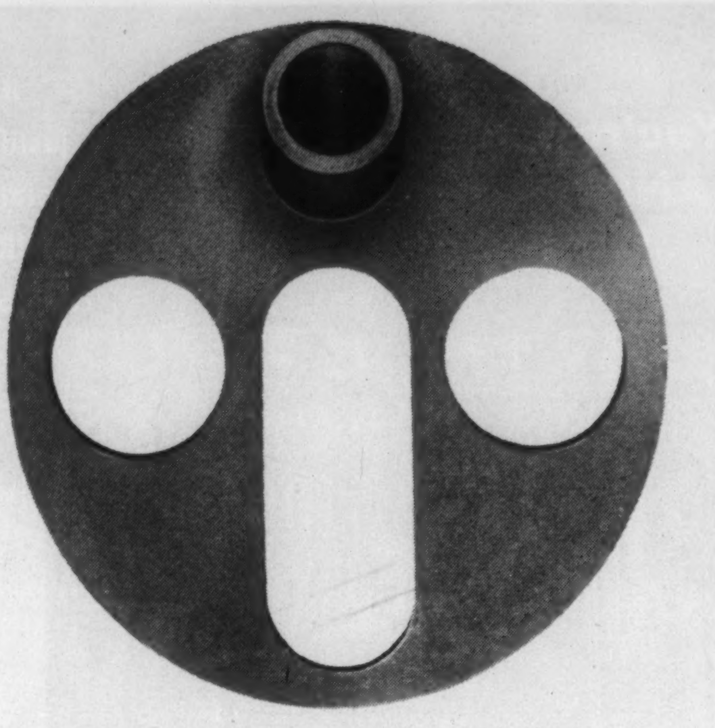
Pliotac is formulated for an open time of 15 min to 1 hr, depending on the conditions of application. Coated surfaces are then placed together with sufficient pressure to assure good contact. Vertical surfaces or highly porous materials may require two coats, with an hour between coats suggested.

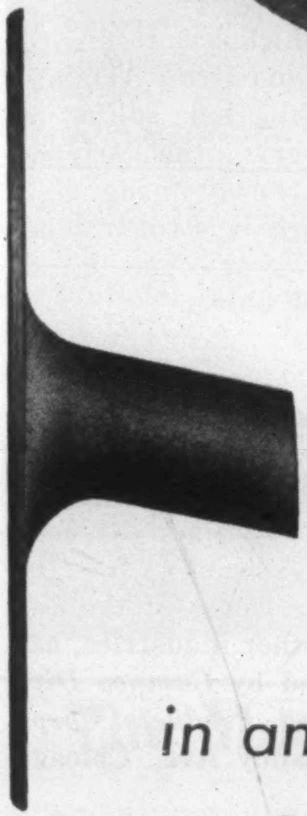
Coverage is 100 to 200 sq ft per gal depending upon the nature and porosity of the laminates.

Surface Treatment for Glass Containers

A new, multi-purpose surface treatment for glass containers, called Duracote, has been developed by *Owens-Illinois Glass Co.*, Toledo, Ohio. It is said to have all the advantages of surface treatments presently in use, but none of their disadvantages. It is







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Aircraft Quality STAINLESS INVESTMENT CASTINGS

in any shape or grade . . .

Can your product benefit from the important features shown in these Crucible Accumet® precision investment stainless castings? They are tube supports for jet aircraft engine assemblies, but the characteristics they illustrate are just as vital to thousands of other applications.

THIN WALLS — Accurately produced by the Accumet casting process, they are impossible to make in sand or shell mold castings — very difficult to forge.

BLIND HOLES — like this one, are impossible to forge, expensive to machine, and very difficult to sand cast . . . but they can be held to close tolerances by Accumet casting.

CORING — Deep or intricate cores — prohibitively costly to machine — can be economically produced by the Accumet process.

ODD SHAPED PARTS — difficult to chuck and machine, are economical when they're Accumet castings.

Next time your designs call for parts with intricate shapes . . . close tolerances . . . fine finish . . . high quality and uniformity, make them Crucible Accumet castings. They are available in any grade of steel or high alloy your product calls for. Let a Crucible engineer give you all the facts about how Accumet castings can save you time and money. *Crucible Steel Company of America, The Oliver Building, Mellon Square, Pittsburgh 22, Pa.*

Write for a free copy of the informative folder "Accumet Castings".

CRUCIBLE first name in special purpose steels

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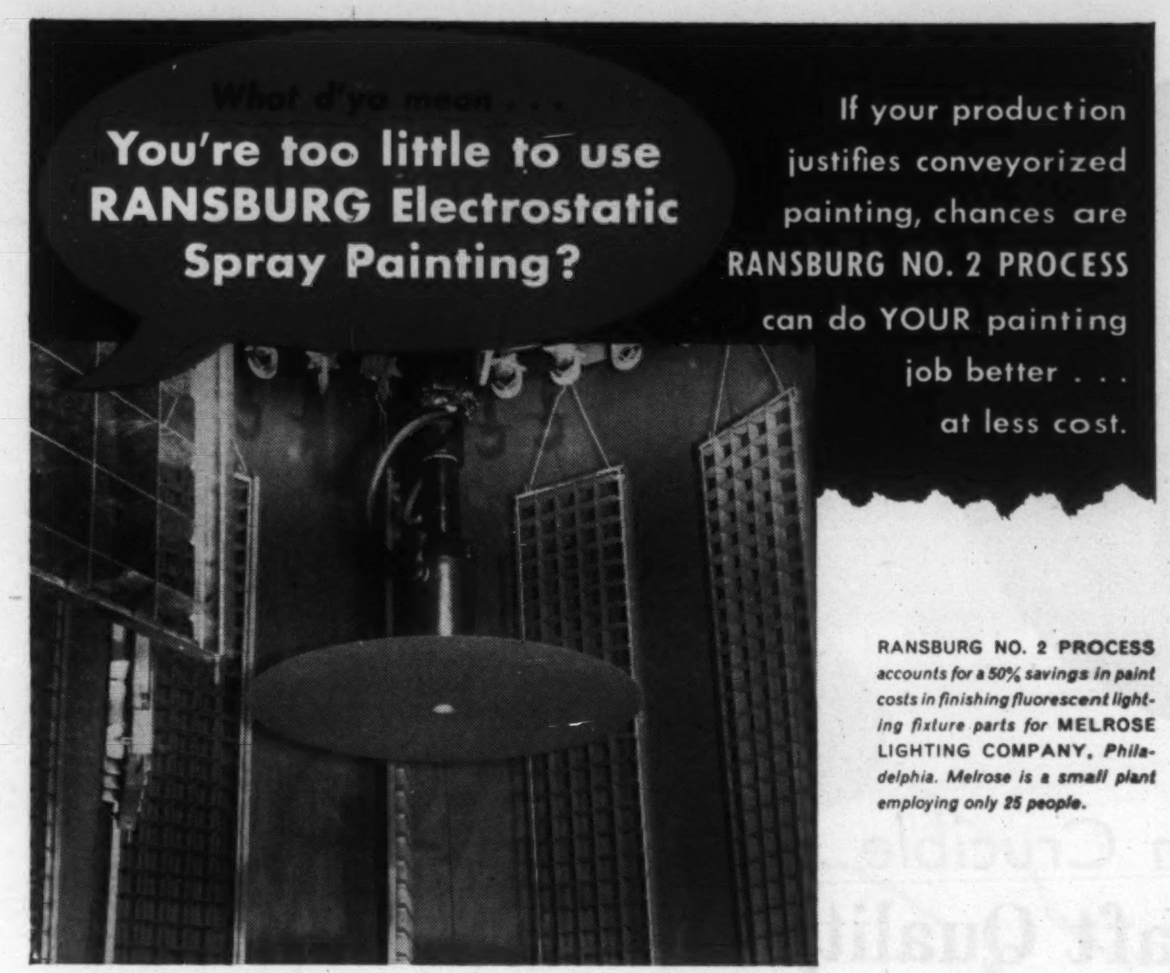
What d'yo mean . . .
You're too little to use RANSBURG Electrostatic Spray Painting?
If your production justifies conveyorized painting, chances are RANSBURG NO. 2 PROCESS can do YOUR painting job better . . . at less cost.

RANSBURG NO. 2 PROCESS *accounts for a 50% savings in paint costs in finishing fluorescent lighting fixture parts for* **MELROSE LIGHTING COMPANY**, *Philadelphia. Melrose is a small plant employing only 25 people.*

Not only big industrial manufacturers like G. E. . . . Whirlpool-Seeger . . . Westinghouse and Republic Steel, but little plants, too, are using RANSBURG NO. 2 PROCESS in their finishing departments to help keep mounting manufacturing costs in line.

A typical example is Melrose Lighting Company, Philadelphia. They make industrial fluorescent lighting fixtures and employ only 25 people.

Formerly, according to F. Homer Hagaman, owner Melrose Lighting, when their fixture louvres were hand sprayed, they painted only 70 pieces per hour. Now, with Ransburg Electro-Spray, he reports they get over 200 per hour.

Production on the fixture end parts jumped from 400 pieces per hour by hand spray to over 2000 an hour electrostatically—a 400% increase!

Along with improving quality of the work, stepping up production, and cutting labor costs, Melrose is enjoying a 50% paint savings.

Let us show you how Ransburg No. 2 Process can lower YOUR painting costs. Write for our new No. 2 Process brochure on electrostatic spray painting. Numerous production-line examples show how other manufacturers are cutting finishing costs . . . increasing production . . . and improving the uniformity and quality of their work with Ransburg equipment.

Ransburg ELECTRO-COATING CORP.
Indianapolis 7, Indiana
RANSBURG

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durable, nontoxic, permits easy labeling, and can be used on all types of glass containers.

The surface treatment is described by company officials as both a material and a process. It is a water insoluble organic polymer, applied to new glass containers at the glass plant, as they move from the forming line through a cooling cycle in annealing lehrs.

Duracote, which has received a Federal Food and Drug Administration non-objection ruling, is said to preserve the original strength of a newly made glass container, which is strongest before it is handled or comes in contact with other objects.

Extruded Styrene Sheet for Printing Purposes

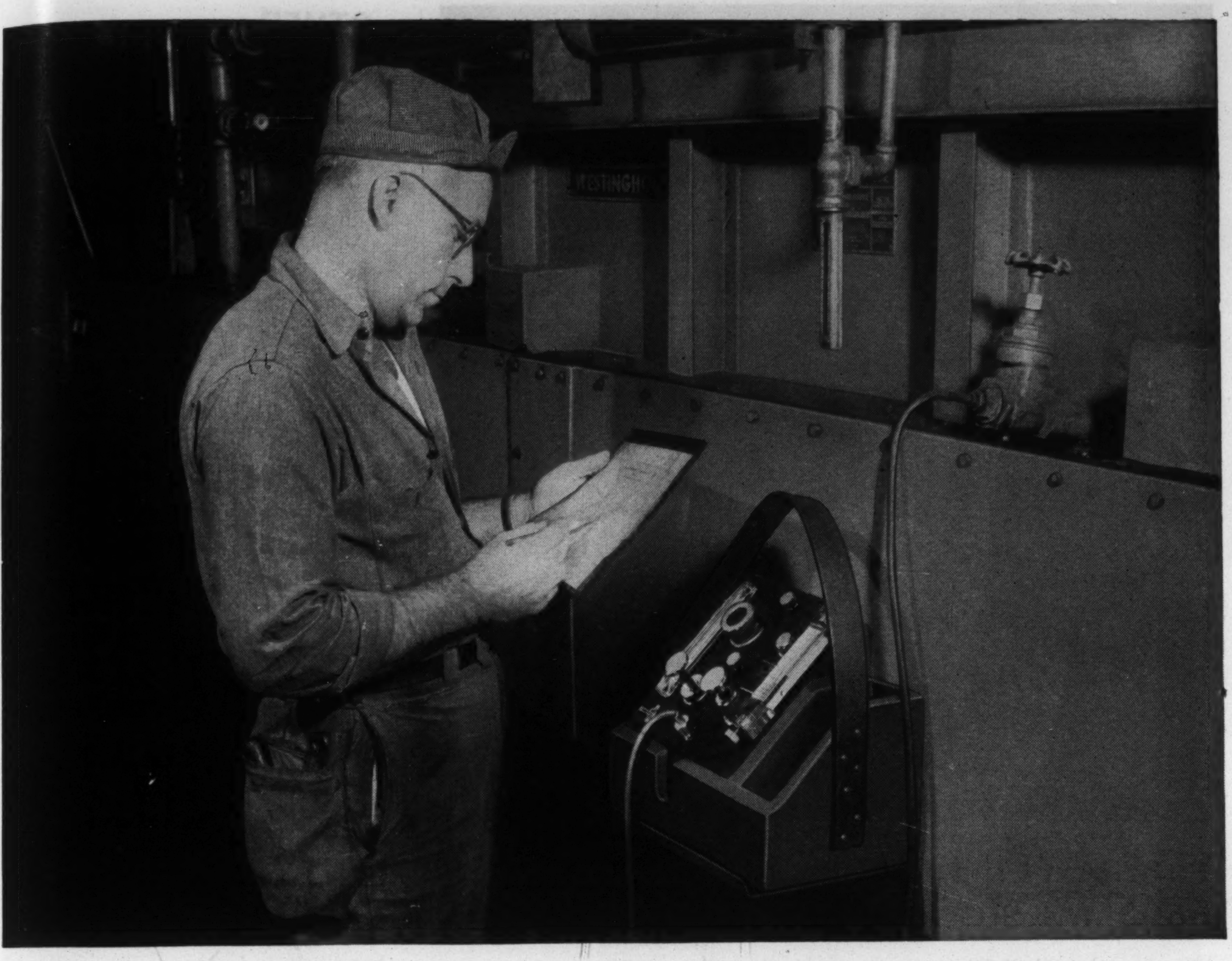
A modified styrene extruded sheet, made especially for the printing requirements of the display, toy and other industries, has been introduced by *Campco Div., Chicago Molded Products Corp.*, 2717 N. Normandy Ave., Chicago 35, Ill.

Called Registrite, the material is claimed to have a more uniform strain pattern, superior color, and a lower cost than materials previously used for print register applications.

Said to have high impact resistance and excellent formability, the plastics sheet possesses an ideal surface for printing ink adhesion, and its blue-white color enhances printed colors. It is available in thin gages for display work.

Coated Dynel Fabric Is Fire Resistant

A fire resistant aircraft trim material, made of vinyl-coated Dynel fabric, is now being produced by *Sawyer-Tower, Inc.*, Stanley Ave., Watertown 72, Mass. The trim can be tailored easily



The Most Valuable Information for the Heat Treater...

"The most valuable information for the heat treater... is accurate, reliable data to show him how to adjust furnace atmosphere."

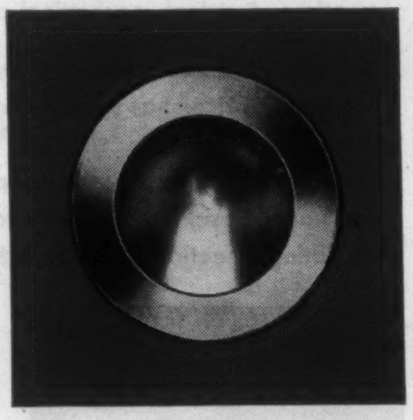
That is one of the most significant quotes from papers presented at the recent National Metal Congress. And the practical answer on control of furnace atmospheres is to determine carbon potential by reading dewpoints in each furnace zone with an Alnor Dewpointer.

With the Dewpointer You Can:

1. Read Each Furnace Zone. With the portable, self-contained Dewpointer, you can readily check each zone in the furnace . . . instantly detect restricted flow of atmosphere, leaky furnace seals or transient moisture and air from the quench tank, and air carried into the furnace with the charge.

2. Get Accurate Data. Only the Dewpointer gives you controlled testing conditions . . . indications take place in enclosed chamber. Dew or fog is suspended in air as sunbeams—not on a polished surface. This gives you the greater accuracy, faster readings required for critical atmosphere control.

3. Fast, Easy Reading. In one relatively inexpensive instrument, the Dewpointer brings you simple, direct operation that enables any shop man to get readings with laboratory accuracy—every time. It is wholly self-contained, no cooling equipment required. Operates on either AC or enclosed battery.



Eliminate Guesswork

You actually see the dew or fog suspended in a test chamber—no guessing as to when fog starts to form on polished surface. Find out why the Dewpointer is so widely used for accurate atmosphere control. Send for your copy of new illustrated Dewpointer Bulletin.

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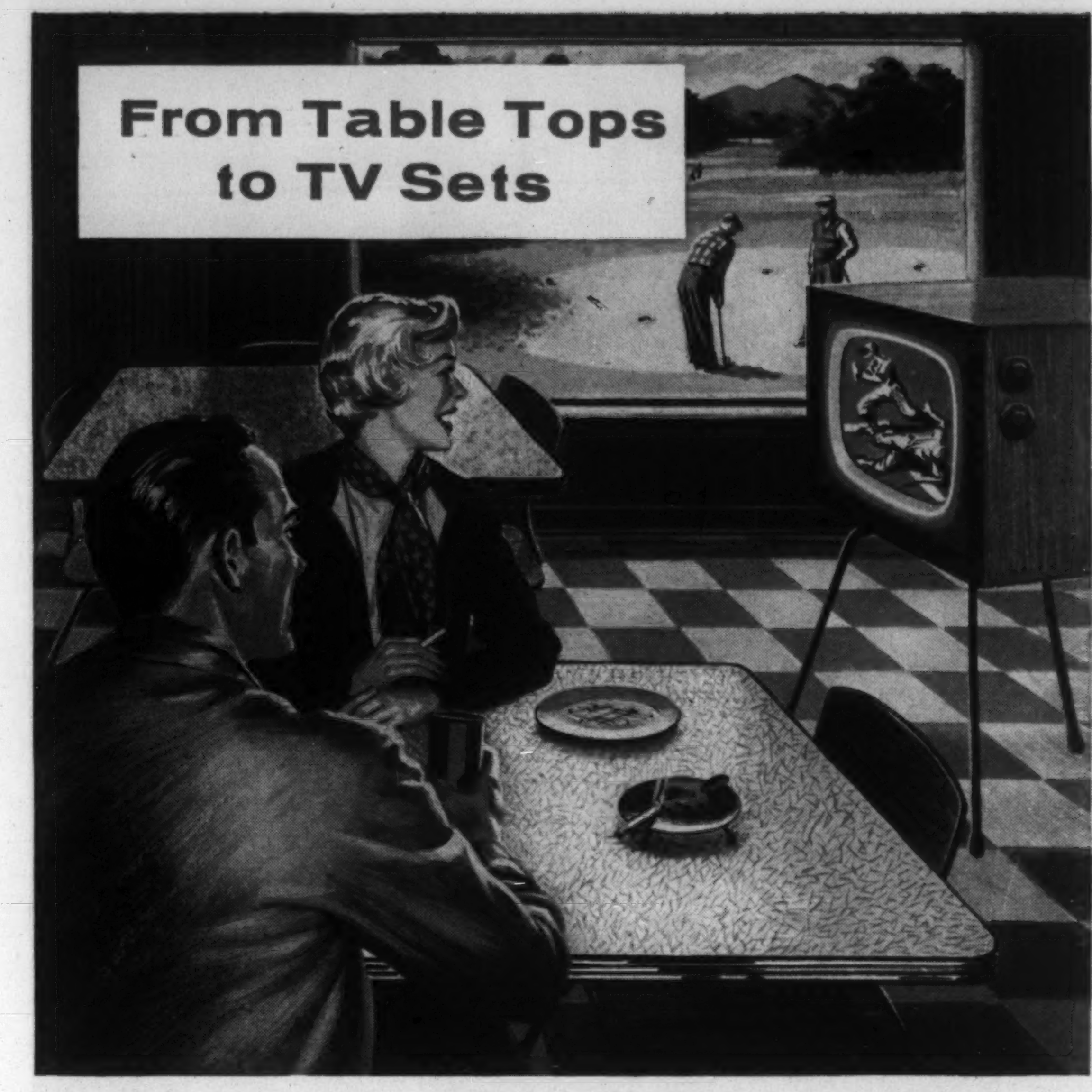
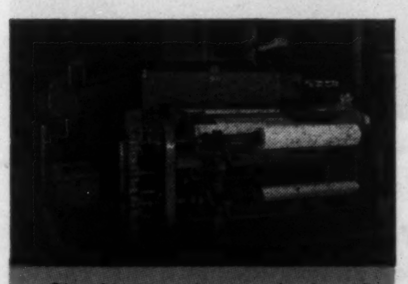


From Table Tops
to TV Sets

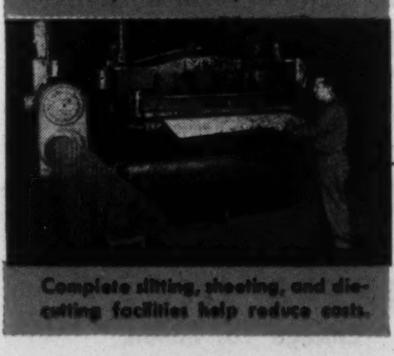
Fabricon Plastic Impregnated Materials help MAKE GOOD PRODUCTS BETTER!

When it comes to plastic impregnated papers for laminating or molding applications, you'll do well . . . *always* . . . to think of Fabricon *first!* First for melamine impregnated patterns, wood grains, solid colors, and translucent overlays for durable decorative laminates. And first, too, for phenolic impregnated N.E.M.A. industrial grades for countless electrical, mechanical and structural uses.

Yes, regardless of what your requirements are for plastic impregnated papers, you'll find that Fabricon has what it takes to deliver the quality and service you're looking for. Years of experience with all types of thermosetting resins and fillers. Complete laboratory facilities for developing new products and processes. Special production equipment designed for continuous, precisely controlled operation. Plus facilities, too, for slitting, sheeting, and die-cutting to size and shape required.



Giant impregnating ovens having roll capacities up to 90" in width assure efficient, economical production.



Complete slitting, sheeting, and die-cutting facilities help reduce costs.

But papers for industrial and decorative laminates are only one of the many different types of plastic impregnated materials now being produced by Fabricon to help make good products better. Others include asbestos, glass cloth, cotton duck, filter cloths and papers, plus a number of other special materials developed exclusively by Fabricon to fulfill the specific requirements of a wide range of products, *perhaps yours included!*

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and may be scrubbed with soap and water without harm. Surface texture can be varied by treating the vinyl coating.

The combination of a fire resistant supporting fabric (Dynel) and a vinyl coating, is said to make the material particularly suitable for headliners, side panels, wainscoting, luggage rack protectors, insulation blanket covers and other aviation trim.

Available in standard 44-in. widths in a range of interior colors, the fabric may be had in either plain or perforated styles.

Low Priced Coating for Zinc Plated Parts

A low priced, single dip, no leach conversion coating for zinc plated surfaces has been announced by *Chemical Corp.*, Springfield, Mass.

Called Luster-On 52 Powder, it is said to eliminate expensive handling and storage, as well as carboy deposits encountered with chromate coating techniques. The dip gives a bright bluish hue to the zinc plated surface and protects it against staining, tarnishing and white powder deposits.

The chemical is intended for automatic equipment where facilities are not available for added leaching and rinsing. It can also be used where cost has prohibited the use of chromates in the past, e.g., electrical conduit, screws and builder's hardware, tools, electronic parts, air conditioning parts, automotive parts and cheap toys.

Sealed Hardboard Has Durable Light Color

Long fiber Douglas fir, processed and refined, is the basis of a light colored, prefinished, tempered hardboard called Sandalwood. Developed by *Forest Fiber Products Co.*, Forest Grove, Ore., the board is said to have a sealed,

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Now and in the years to come, more and more products will become possible and practical with Styrex 767.

STYREX 767 opens new horizons for the plastics industry...*here's how*–

Here's real news! Styrex® 767, with superior crazing resistance, lends itself to applications previously considered impossible with thermoplastic materials. Plans heretofore unworkable can now be dusted off and brought to reality!

There are many reasons designers will want to start working with Styrex 767 right away—

An improved copolymer of styrene acrylonitrile, Styrex 767 is a rigid thermoplastic that is readily molded or extruded. It also has an excellent balance of physical properties. A high degree of toughness and heat resistance are combined with superb stress strength. It is resistant to acids, bases, salts, oils, waxes, soaps, food stains, and many solvents including gasoline and kerosene. Styrex 767 can be readily machined and decorative coatings are practical. It is available in natural color as well as transparent and opaque. Styrex 767 provides a new high standard of transparency in sparkling clear-toned colors. And Styrex 767 is already in full scale production, assuring availability of the product when you want it.

No matter what plastics you are using, you'll want to test this important contribution to the advancement of the industry—

Styrex 767 is the first of a family of new Dow plastics based on styrene acrylonitrile. Phone, wire or write for complete technical and application information. You'll find means to enlarge your markets, extend your fields of operation.

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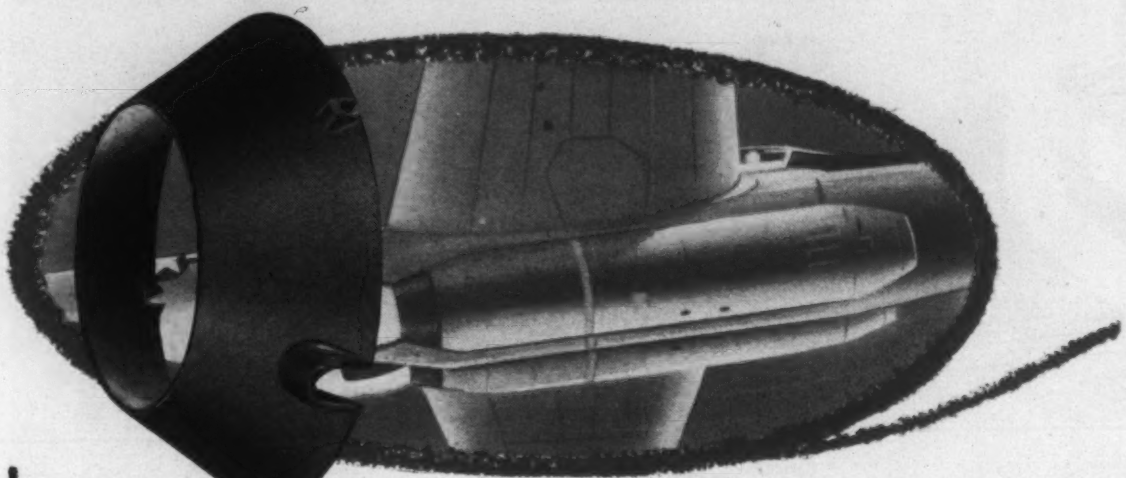

APPLICATION:
Thermal barrier for jet aircraft accessories.

PROBLEM:
The original part, along with drawings and molds, was presented to Acushnet by a well-known manufacturer of accessories for conventional and jet aircraft with orders to continue development with Dow-Corning 301 compound. The idea was to attain a part that would provide maximum physical properties at elevated temperatures of over 800°F.

SOLUTION:
Overcoming the high bulk factor of the compound was accomplished through the design and construction of a preform. Running the original mold in a special hydraulic ram equipped with controls permitting a wide range of temperatures and pressures, provided the necessary information in curing this compound. The resultant cure times and pressures enabled Acushnet engineers to design and construct a compression mold of hardened steel that made this part possible. Included in this project were small gaskets molded from Dow-Corning 301 that proved superior to metal in high heat insulating applications.

Pioneers in the advanced mold techniques and custom compounding of silicones, Acushnet now offers you immediate technical assistance in the molding and finishing of silicone resins.

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washable surface, good durability and good weather and scuff resistance. The color is baked in and is not a coating.

Food oils, dirt, bleaches and ink can be wiped off easily without showing any stains. The board can be used as is, or it may be painted in one coat without primers or sealers.

The material possesses the characteristics of wood in that it may be sawed and nailed. However, the surface is said to be much superior to that of a normal wood product, and is tough enough to take almost any type of wear.

Although ideal for floors, counter tops and desk tops, it is expected to be useful in other products requiring a hard wearing surface. The material is available in 4 x 4 ft to 4 x 16 ft sizes. It can be used either indoors or outdoors. Temper treated Sandalwood is also available with a punched surface for specialized uses.

Four Brazing Alloys for High Temperatures

Four high nickel content brazing alloys, meeting AMS specifications 4775, 4777 and 4778, have been introduced by *Handy & Harman*, 82 Fulton St., New York 38, N. Y. Called Handy Hi-Temp, the alloys are designated 93, 91, 82 and 72, based on their approximate nickel contents.

Unlike silver, brass, copper and bronze, the alloys are said to actually alloy with the base metals

***High nickel** content brazing alloys are available as cast rod, powder, resin-bonded sheet and sintered forms.*

during the brazing cycle. They are particularly useful for brazing austenitic stainless steel, high nickel heat resistant and precipitation hardening alloys, and carbon steel and nonferrous metals having melting points above 1850 F. Their mechanical properties and corrosion and oxidation resistance closely approximate those of stainless steel and heat resistant alloys.

The four alloys have chemical compositions ranging from 72 to 93 nickel, 3 to 5% silicon and 1 to 4% boron. They are self-fluxing when used in a controlled atmosphere of dry hydrogen, argon or helium, and they can be brazed in atmospheres of exothermic or endothermic gases and in air with the addition of a flux. Standard brazing furnaces and salt baths operating at about 2150 F may be used for brazing. Cleaning and brazing procedures are generally similar to those for silver filler metals.

Properly designed joints have tensile strengths of 75,000 to 95,000 psi depending on the atmosphere used, joint clearance and composition of the brazing alloy.

Applications for the alloys include joining heat resistant parts for jet engines and rocket motors, honeycomb structures, heat exchangers, and corrosion resistant equipment for food, dairy and chemical processes.

The alloys have flow points in the range of 1825 to 1925 F and are available as cast rod, powder and resin-bonded sheet, as well as forms fabricated and sintered from the powder.

Perforated Mylar Film Available in Colors

A new development in processing Mylar film has been announced by the *Kendall Co., Plastic Film Sales Dept.*, 309 W. Jackson Blvd., Chicago 6, Ill.

The heat sealable polyester film is produced in straight or stag-

For more information, Circle No. 569

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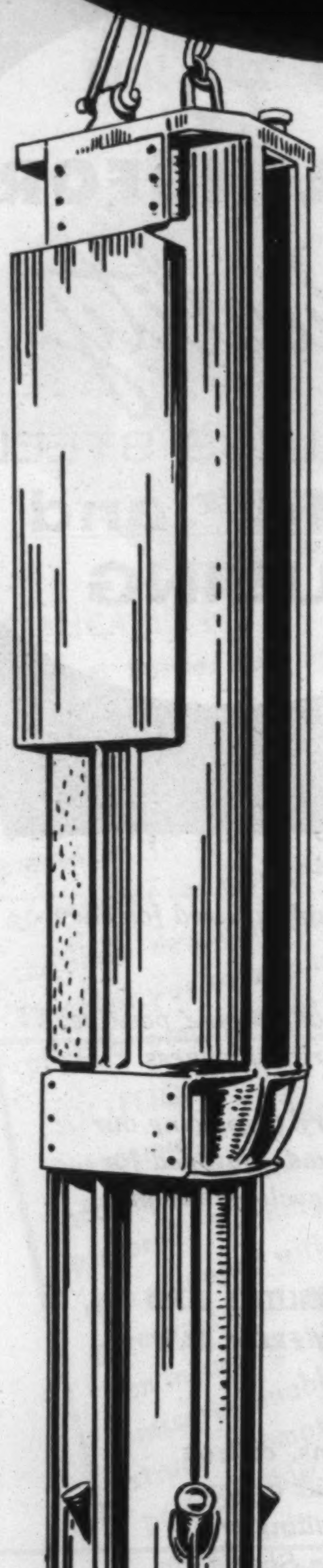

One million foot-pounds of energy per minute. That's what the McKiernan-Terry Pile Hammer delivers, averaging 18,000 foot-pounds per blow in striking up to 60 blows per minute. Such rugged service demands the ultimate in materials.

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West Coast Affiliate

OTHER NEW MATERIALS PRODUCTS

gered patterns with perforations measuring 0.020 to 0.203 in. and numbering 14 to 900 per sq in. Thickness of the film ranges from 0.25 to 3 mils, and width from 1 to 36 in. It is available metallized, colored and plain.

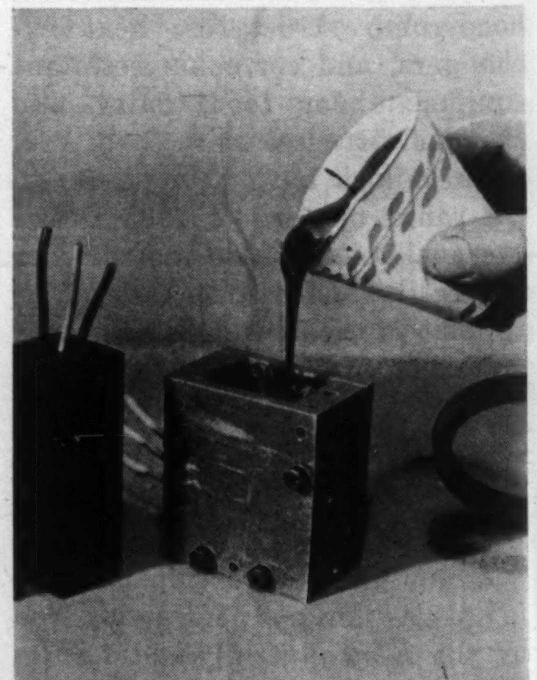
Suggested uses include electrical insulation, filter or screening material, packaging material, laminations, silk screens and breathing membranes.

Two Epoxide Products for Casting, Packing

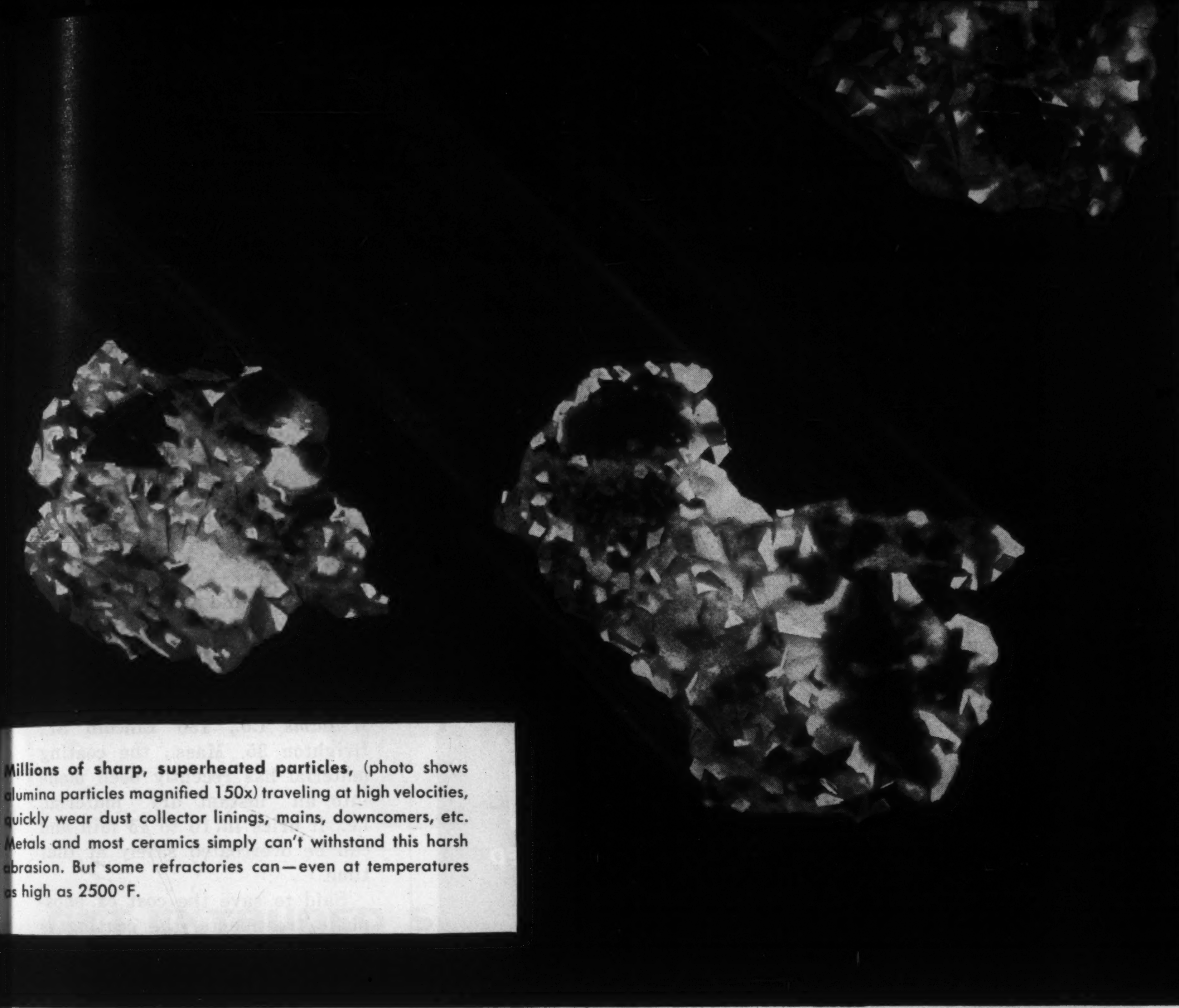
Two new epoxide materials have been introduced by *Emerson & Cuming, Inc.*, 869 Washington St., Canton, Mass. One is an epoxide "pack-in-place" foam called Eccofoam PT. It is recommended for electronic assemblies, for void filling in aircraft, and for insulation and bouyancy applications.

Cured Eccofoam PT can be used at temperatures to 350 F. It has a density of less than 20 lb per cu ft and a flexural strength of 800 psi. It has a low dielectric constant and a low dissipation factor.

The other product, designated Stycast 2741, is a flexible epoxide casting resin with negligible



***Pouring** epoxide casting resin Stycast 2741 into a mold to form electronic part shown at left.*



Millions of sharp, superheated particles, (photo shows alumina particles magnified 150x) traveling at high velocities, quickly wear dust collector linings, mains, downcomers, etc. Metals and most ceramics simply can't withstand this harsh abrasion. But some refractories can—even at temperatures as high as 2500°F.

Refractories . . . where abrasion is a problem

Unequalled resistance to abrasion whether caused by tiny gas-borne particles or sliding steel billets—is one of the most useful properties of CARBOFRAX® silicon carbide refractories. For example, a CARBOFRAX dust collector lining on an ore sintering machine is still in use after 10 years service.

And when abrasion is combined with high temperature, the exceptional resistance of CARBOFRAX super refractories becomes even more apparent and useful. When used in the exhaust lines of gasoline catalytic cracking units in temperatures ranging around 1200°F, these refractories lasted 3 years, as compared to alloy rings which lasted for 6 months. On a gas fired extrusion mill furnace—where steel skids lasted 5 weeks—CARBOFRAX refractories lasted 156 weeks.

Wear resistance is not the only unusual property of these refractories. They also offer heat conductivity roughly 11 times that of fireclay, with sufficient hot strength to withstand 25 psi at 1720°C. CARBOFRAX refractories are but one of many super refractories pioneered by Carborundum and offering a wide range of unusual properties.

Carborundum's new magazine "Refractories" pinpoints many practical applications for these unusual products. The forthcoming issue carries a feature article on "Wear Resistance". Send for your copy today.

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shrinkage. This material is reported to retain its flexibility at —70 F. It can also be used at 300 F. It is recommended for encapsulating, potting and sealing applications at low temperatures.

Fast Drying Primer Lowers Coating Costs

Adhesion of paint films to smooth surfaces such as galvanized sidings and aluminum sheets, can now be promoted through use of a clear metal coating called Totrust Metal Bond.

Developed by the *Wilbur & Williams Co.,* 130 Lincoln St., Brighton 35, Mass., the coating material has recently been made into an "instant dry" material, i.e., it dries in 10 to 15 min and can be overcoated safely at that time.

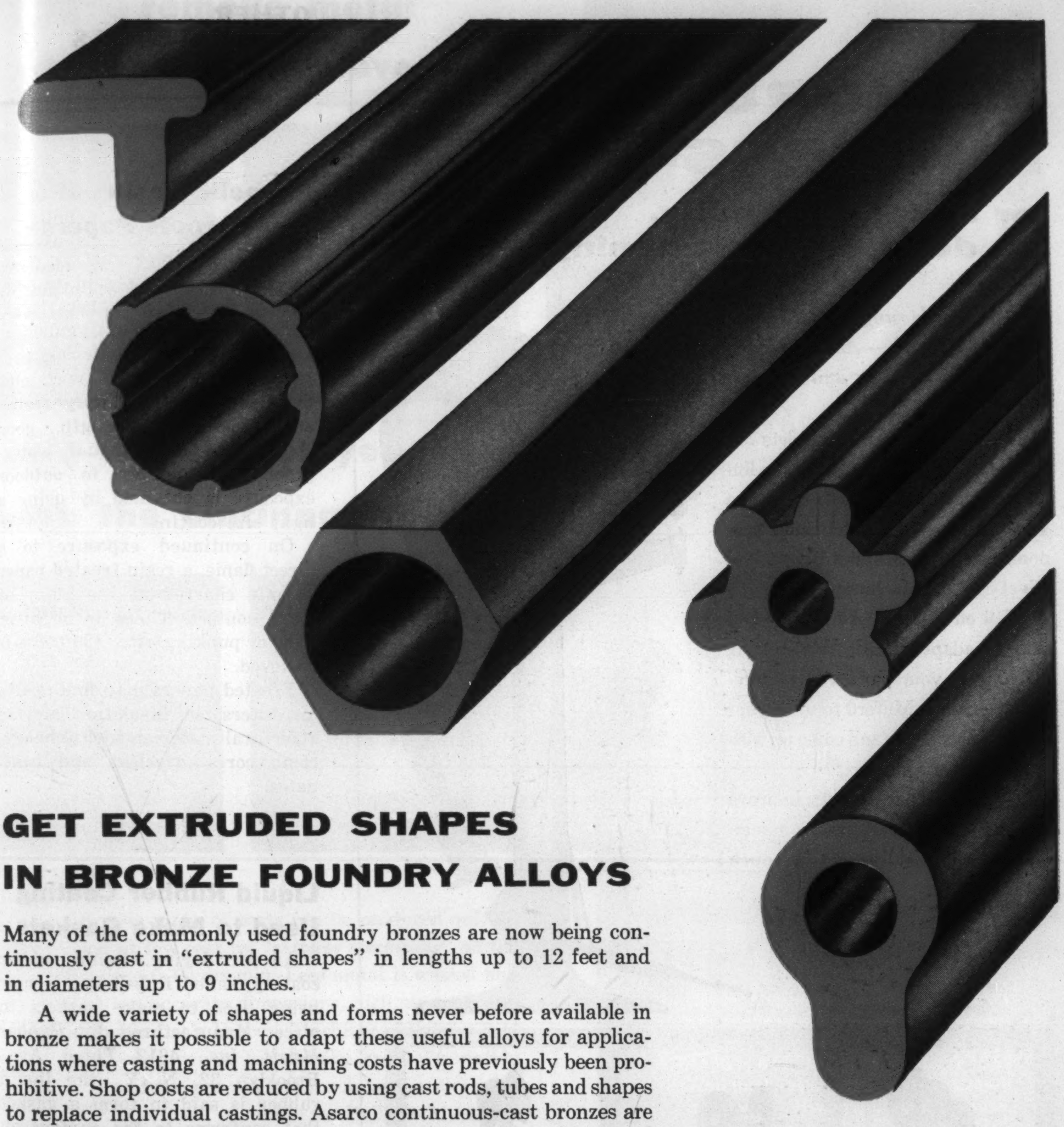
Said to save the cost of phosphate treatments, the coating is applied by brush or spray. In addition to aluminum and galvanized surfaces, it can be used on wood, plastics, brass, tin, copper and cement asbestos boards.

Epoxy-Based Cement for Joining Tile, Brick

An epoxy-based plastics material suitable for joining concrete brick, cement and tile has been introduced by *Permagile Corp. of America,* 37-23 Thirty-third St., Long Island City 1, N. Y.

The waterproof, nonshrinking, nonexpanding material, known as Permagile, is claimed to have an average compression strength of 35,000 psi and a tensile strength of 8-10,000 psi. It is unaffected by temperatures between —20 and 270 F, including repeated freezings and thawings. Although rigid, it exhibits an elasticity 30 to 40 times that of normal concrete.

(more New Materials on p 176)



GET EXTRUDED SHAPES IN BRONZE FOUNDRY ALLOYS

Many of the commonly used foundry bronzes are now being continuously cast in "extruded shapes" in lengths up to 12 feet and in diameters up to 9 inches.

A wide variety of shapes and forms never before available in bronze makes it possible to adapt these useful alloys for applications where casting and machining costs have previously been prohibitive. Shop costs are reduced by using cast rods, tubes and shapes to replace individual castings. Asarco continuous-cast bronzes are ideally suited for machining on automatic screw machines and other high-speed modern equipment.

Practically all of the standard tin-bronze alloys, including lead, zinc and nickel-bearing varieties, are being continuously cast to size. They have consistently better uniformity and machinability for faster work and longer tool life. Physical properties are improved as much as 100 percent over similar alloys cast by other methods.

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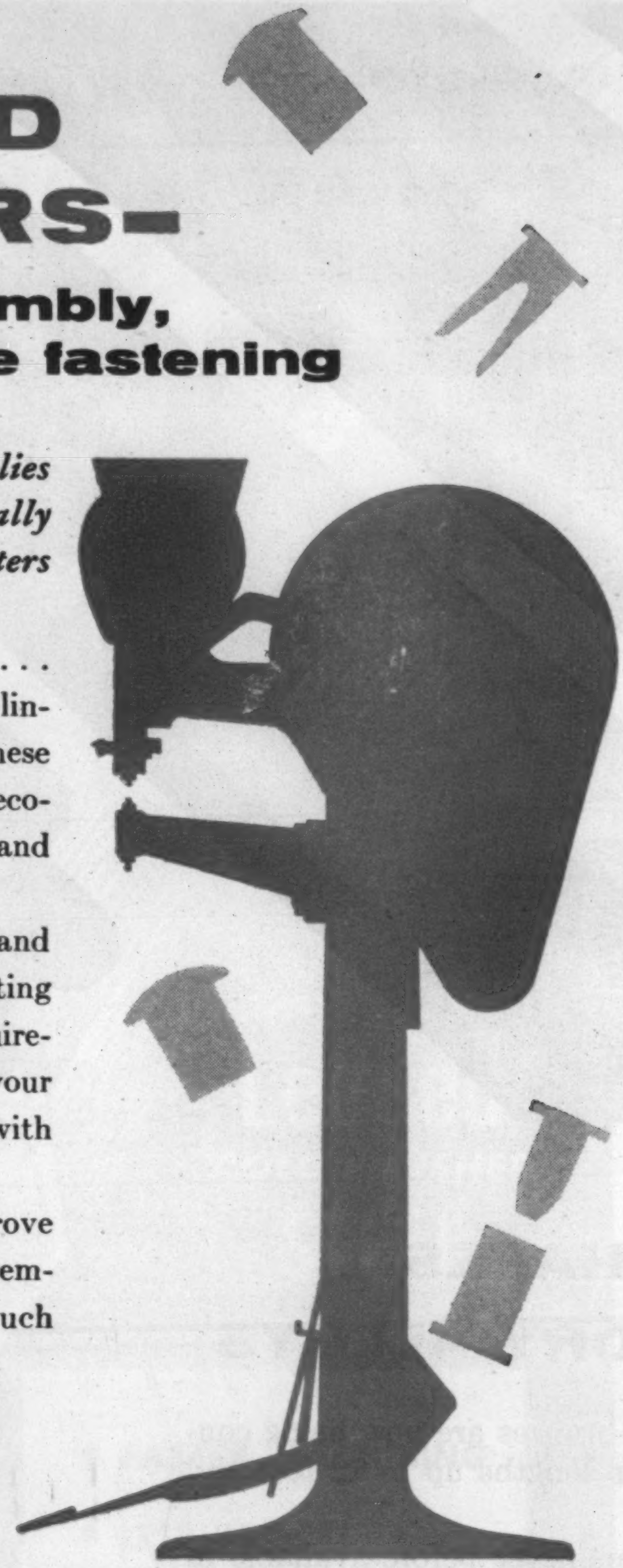
for faster assembly, for dependable fastening

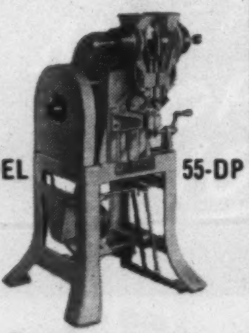


Fasten a wide range of assemblies Safely—Rapidly—Automatically with Milford Rivets and Riveters

Delicate wrist watch bracelets . . . rugged, heavy-duty truck brake lining—a wide range of parts like these are being fastened safely and economically with Milford Rivets and Rivet-Setting Machines.

Call on Milford's versatility and skill to adapt a basic rivet-setting machine to your particular requirements—call on Milford to solve your fastening problems and come up with substantial savings.

To cut production costs, improve product appearance, fasten assemblies automatically—get in touch with Milford!



MODEL 55-DP

Sets two rivets in one operation

MODEL 220-BH

Rivets deep hollow shapes automatically

MODEL 300-BH

Sets heavy-duty rivets rapidly, automatically

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For more information, turn to Reader Service Card, Circle No. 464

OTHER NEW MATERIALS PRODUCTS

Phenolic Resin Flameproofs Papers

A phenolic impregnating resin, called Synco 85, is said to completely flameproof papers, making them self-extinguishing. Developed by *Synco Resins, Inc.*, Bethel, Conn., the resin is claimed to impart good humidity resistance, increased strength, good chemical resistance and waterproofing. Resistance to outdoor exposure is obtained by using a light size coating.

On continued exposure to a direct flame, a resin treated paper is only charred at the point of flame contact. There is no after glow or punking after the flame is removed.

Treated papers may find use in air filters, in insulation and in structural materials such as honeycomb cores, overlays and laminates.

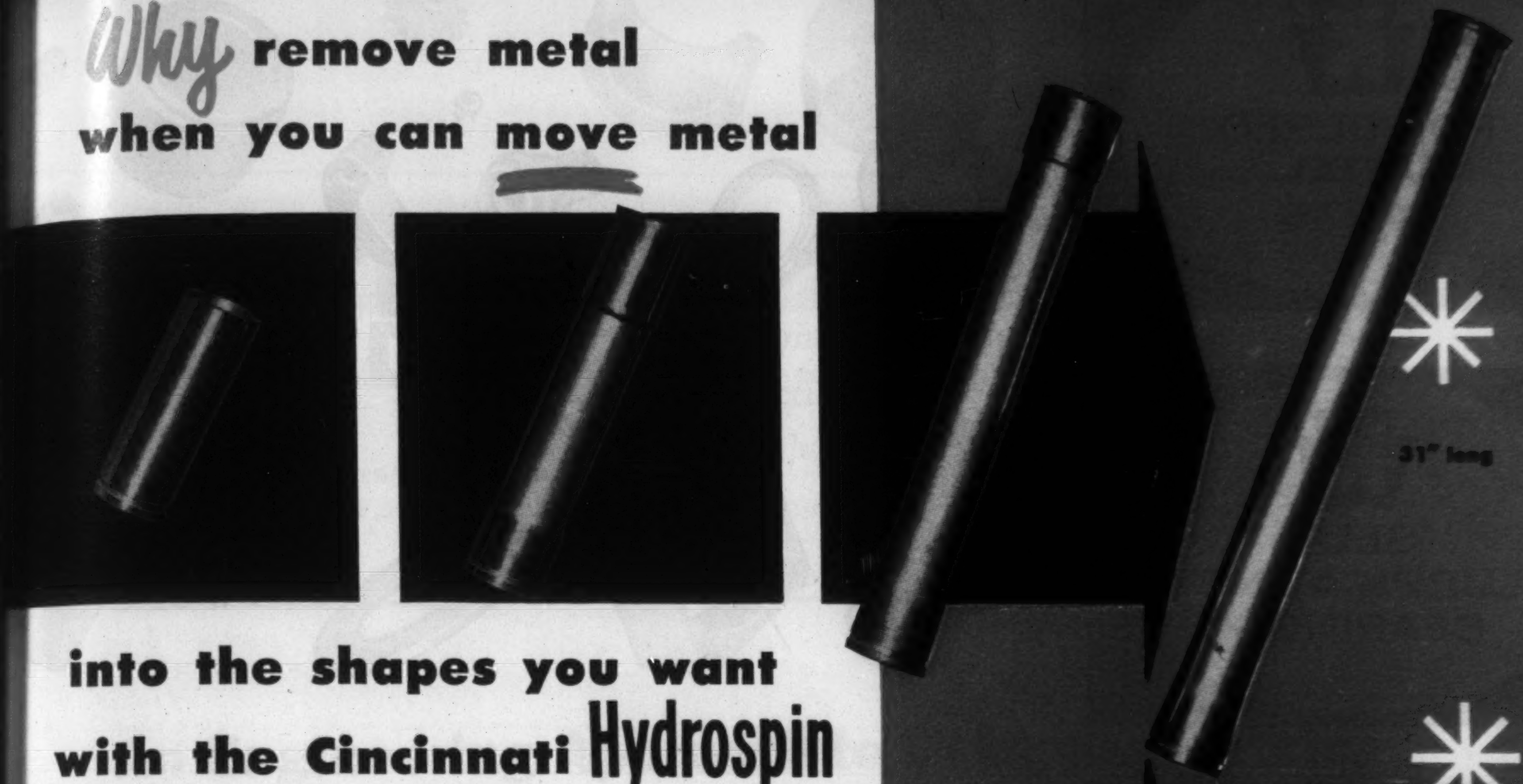
Liquid Rubber Coating Used to Make Gaskets

An air drying, liquid rubber coating, called Rub-R-Ize, is now being used to make gaskets in place. Manufactured by *Rubber Magic, Inc.*, 4312 Third Ave., Brooklyn 32, N. Y., the liquid rubber is said to form a gasket that conforms to the surface on which it is applied, thus eliminating flash (encountered with press cured gaskets) and poor fitting. Thicknesses up to ½ in. may be produced in a single dip through the use of an initial coat of a coagulant.

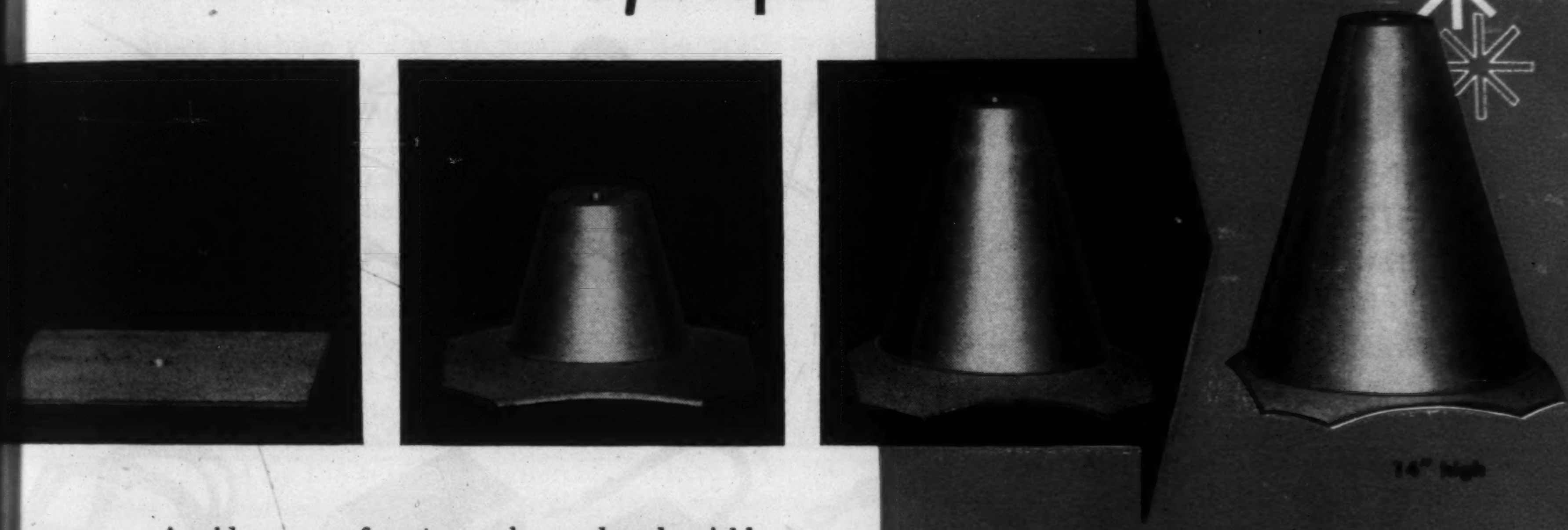
The liquid rubber coating is said to be a fully vulcanized rubber in latex form that requires no heat or outside vulcanizing agents. The rubber deposited is 100% pure gum with a reported tensile of 5000 psi and a modulus of 600 psi at 300%. It is available in red, green, black, grey or transparent.

For more information, Circle No. 366

Why remove metal when you can move metal



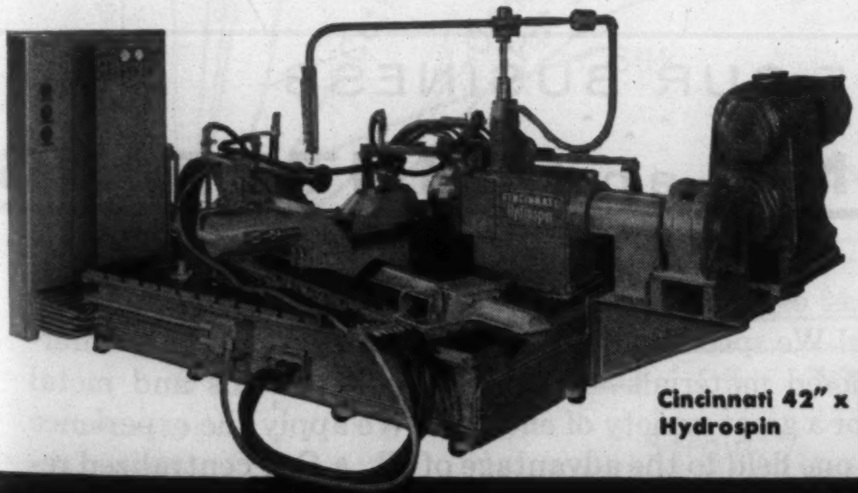
into the shapes you want with the Cincinnati Hydrospin



A wide range of parts can be produced quickly and at low cost by "*chipless machining*" on the Cincinnati Hydrospin. Less metal is wasted and parts have accurate dimensions, high strength and good finish. Let a Process Machinery Division field engineer give you full details. For a description of the process and machine specifications, write for Bulletin M-1873-3.

* Upper sequence of photos shows one *continuous* tube spinning operation. Starting blank, far left, of SAE 4130 is 8¾" long x 3" I.D. x 0.155" wall thickness. Finished part, shown at far right, Hydrospun in one pass, is 31" long x 3" I.D. with 0.030" wall thickness.

** Lower sequence of photos shows one *continuous* shear spinning operation. Starting blank, far left, is of type 302 stainless steel, 12" square x ¼" thick. Finished part, shown at far right, Hydrospun to a 32° included angle in one pass, is 14" high with 0.069" wall thickness.

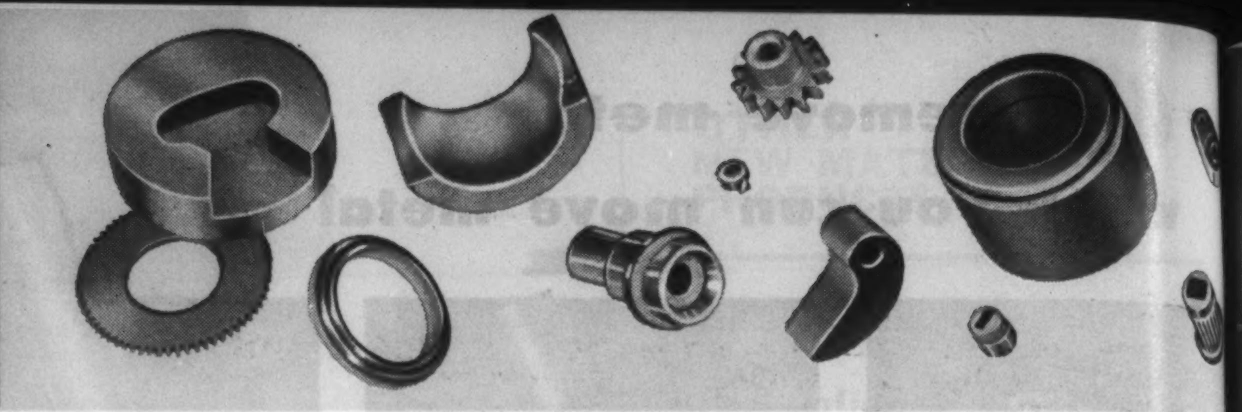


Cincinnati 42" x 50" Hydrospin

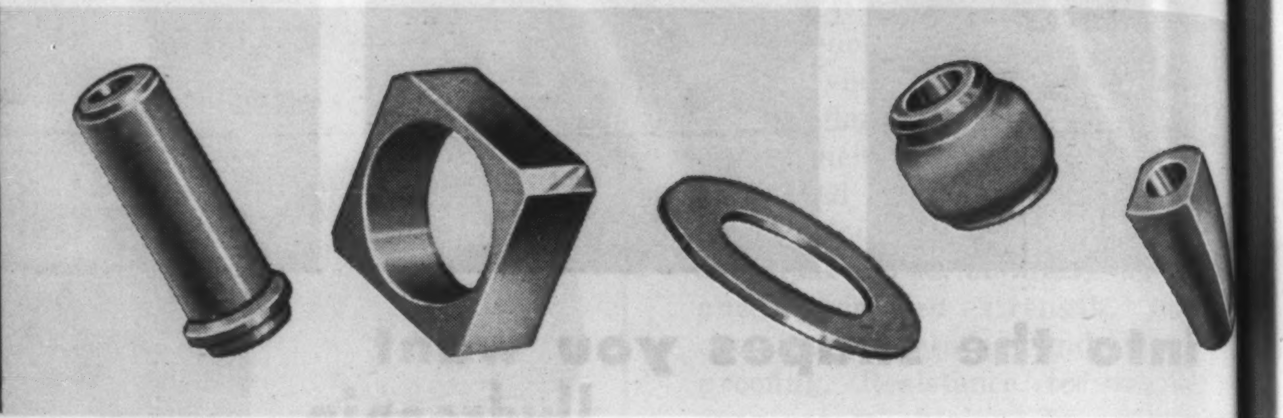
CINCINNATI **Hydrospin**

PROCESS MACHINERY DIVISION
THE CINCINNATI MILLING MACHINE CO.
CINCINNATI 9, OHIO, U. S. A.

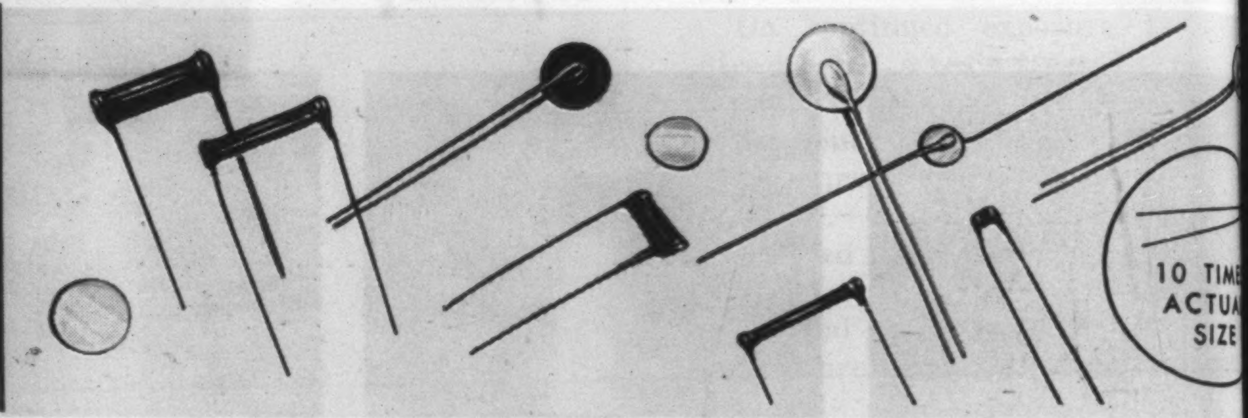
POWDERED
METAL
PARTS



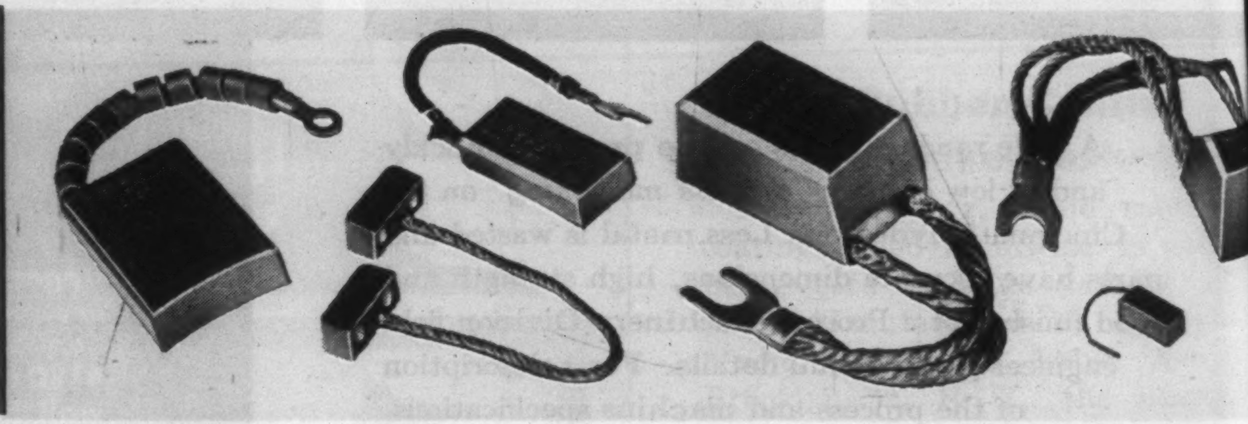
SELF
LUBRICATING
BEARINGS



NTC
RESISTORS
(THERMISTORS)



CARBON AND
METAL GRAPHITE
BRUSHES



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CONTENTS NOTED

Highlights of current papers plus a list of recent books and reports.

This month

- *Engineering in fabric design*
- *Ductility of malleable iron*
- *Evaluating vinyls as finishes*
- *Silicone alloys for dielectric uses*

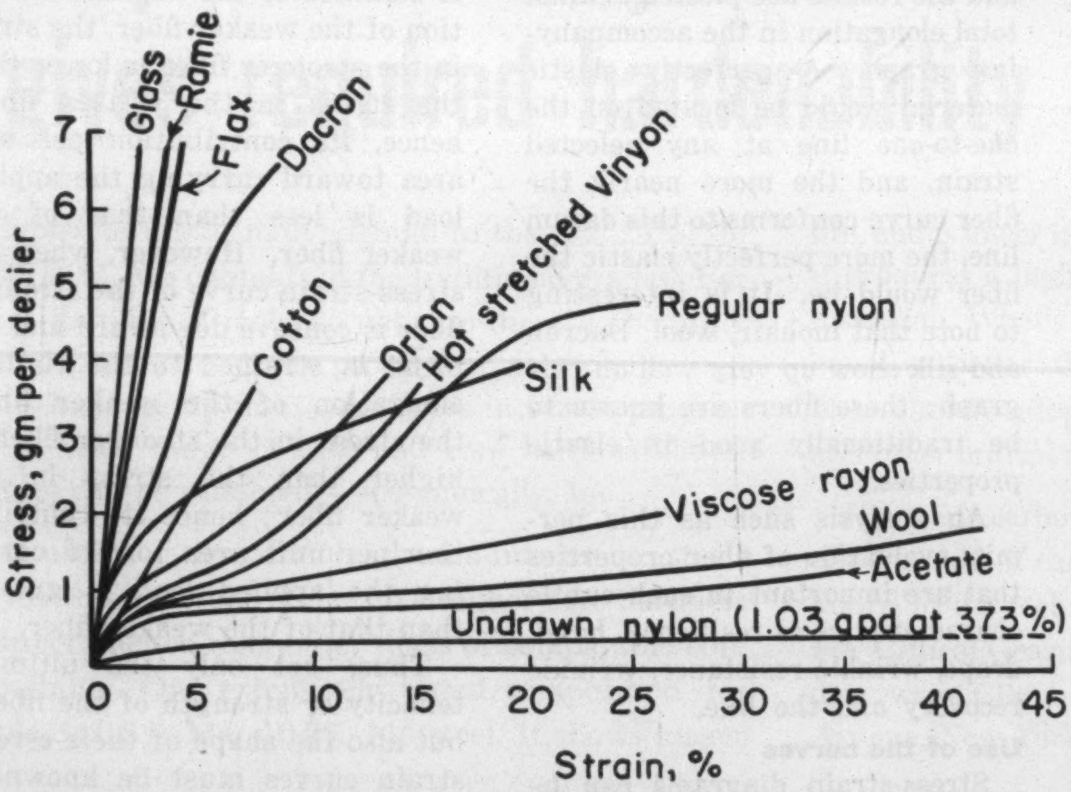
An Engineering Approach to Designing Fabrics

Much has been said of the need for applying sound engineering principles to the design of textile structures, such as industrial fabrics, but little has been done to capitalize on what is already known about textile fibers, yarn and fabric properties. As a step in this direction, Kenneth R. Fox, vice-president of Fabric Research Laboratories, shows in an article in the June '56 issue of *Mechanical Engineering* that many problems faced by the textile designer can be worked out by blending textile craftsmanship with modern textile science.

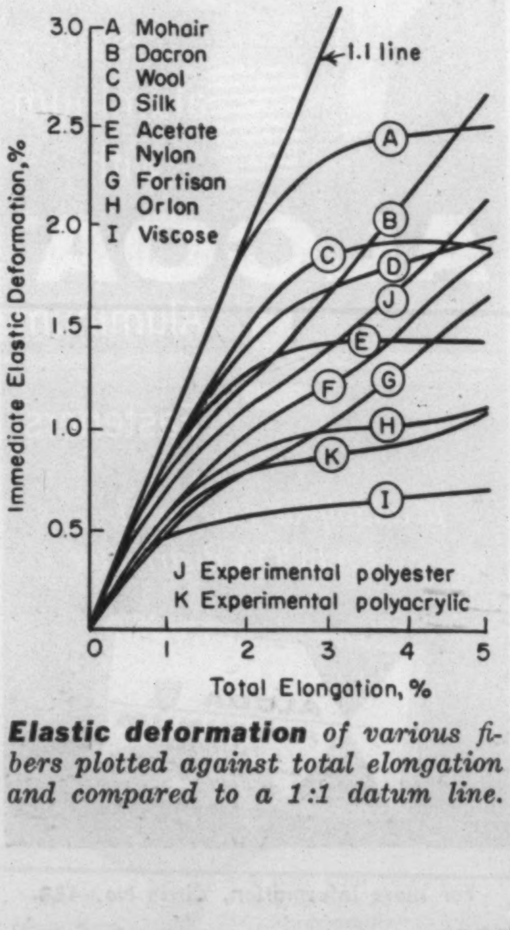
Textile materials are variable; they are frequently difficult to predict; and they are complex structures. But any material, be it steel, copper, cast iron, wood or concrete, is also variable, unpredictable and complex. Ultimate strengths and elongations differ; yield points, elastic and plastic regions vary; and there are very few points of similarity.

There is at the disposal of textile engineers a similar wide variety of fiber properties from which a selection may be made for specific end uses. The extremes range from ramie, a high strength, low extensibility fiber with an almost linear stress-strain curve and an almost perfect elastic behavior over the entire range, to undrawn nylon, which shows a mechanical behavior nearly comparable to that of a perfectly plastic medium.

Most materials, whether conventional engineering materials or textile fibers, react differently



Stress-strain *properties of a wide variety of fibers.*



Elastic deformation *of various fibers plotted against total elongation and compared to a 1:1 datum line.*

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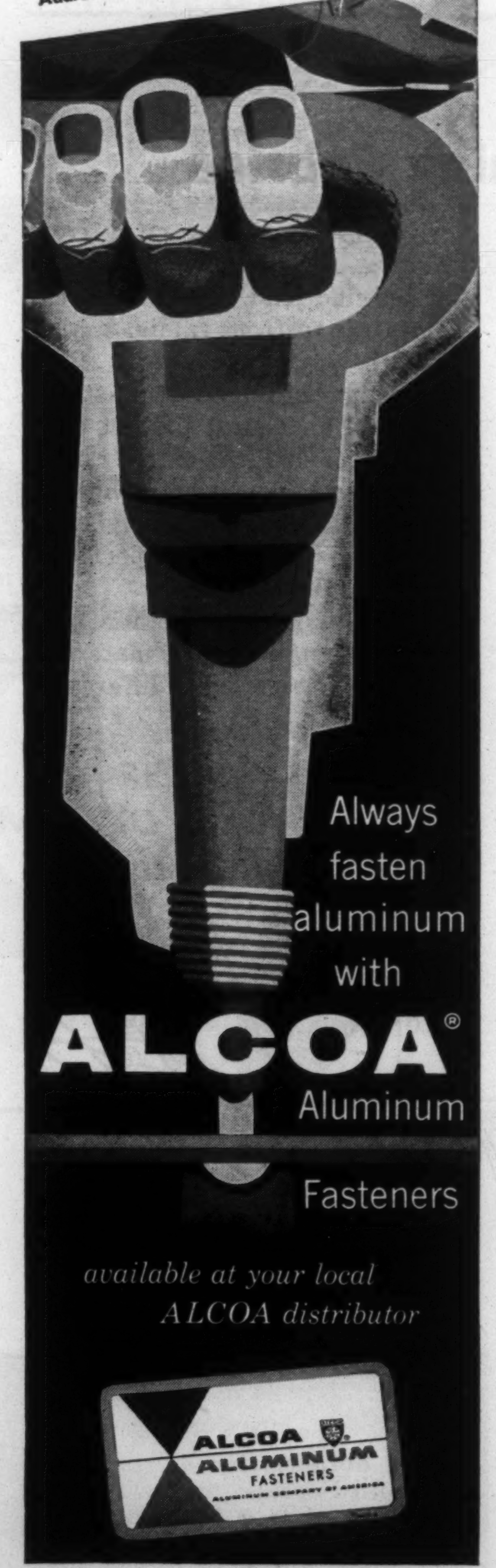


For more information, Circle No. 480

CONTENTS NOTED

when ambient conditions are altered. As temperature increases, moduli are reduced; as temperature decreases, ultimate elongation is reduced, and ultimate strength and energy absorbing capacity are increased. With quantitative data showing how these variables affect specific materials, these materials can be intelligently engineered.

Stress-strain curves

In designing textile structures for decorative fabrics and certain industrial uses, an analysis of the stress-strain curve at low strains is advised. The shape of the stress-strain curve for textile fibers is dependent upon time, i.e. rate of loading. However, an instrument known as the pulse propagation meter permits measuring the modulus of elasticity in essentially zero time. Consequently, time-independent parameters, i.e., the modulus or its reciprocal, "compliance", can be obtained.

A load-compliance diagram makes it possible to determine the immediate elastic deflection at any load by integrating the area under the curve. This has been done for a wide variety of fibers and the results are plotted against total elongation in the accompanying graph. A perfectly elastic material would be located on the one-to-one line at any selected strain, and the more nearly the fiber curve conforms to this datum line, the more perfectly elastic the fiber would be. It is interesting to note that mohair, wool, Dacron and silk show up very well on this graph; these fibers are known to be traditionally good in elastic properties.

An analysis such as this permits evaluation of fiber properties that are important in such subtle characteristics as resiliency, hand, drape, wrinkle resistance, wrinkle recovery and the like.

Use of the curves

Stress-strain diagrams can be used to analyze not only individual fibers but also yarns representing fiber blends. Although fiber blending depends on many properties that are not directly related to stress-strain properties, nevertheless stress-strain relationships ultimately enter the picture to a major extent.

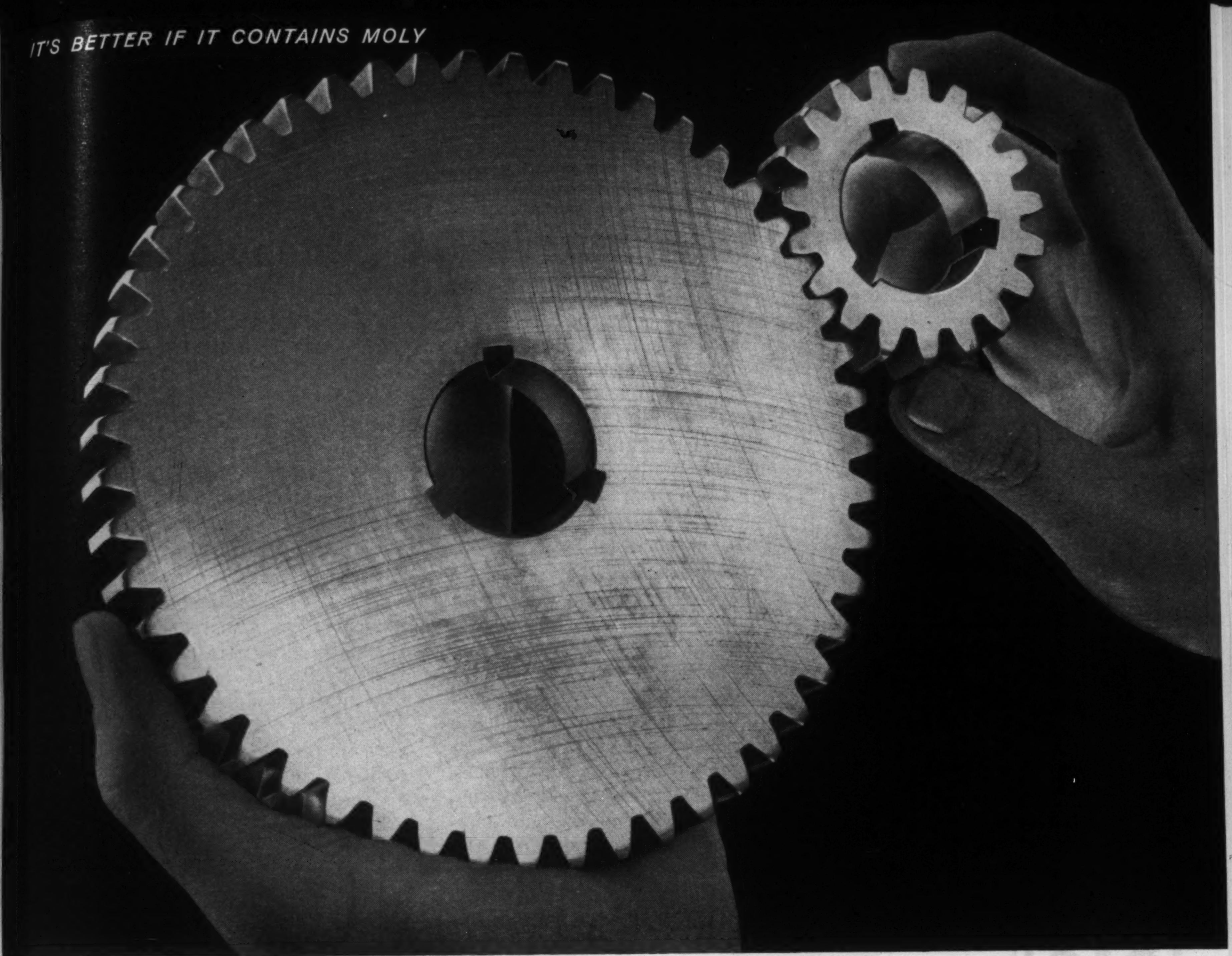
When two or more fibers are blended in a yarn, the shape of the stress-strain curve of individual fibers has a critical effect on the load carrying ability of the yarn at different proportions of fibers. This can be shown by taking as an example a yarn composed of two fibers, one stronger in terms of ultimate tenacity, but lower in modulus than the other. If the stress-strain curves of the fibers are concave upward, certain blends of the two fibers will have a load carrying ability lower than that of a yarn composed only of the weaker fiber. On the other hand, if the shape of the stronger fiber's stress-strain curve is concave downward, the load carrying ability of any blend of the two fibers will be higher than that of yarn of the weaker fiber alone.

Effect of shape

These facts can be readily demonstrated. When the stress-strain curve of the stronger fiber is concave upward, and the blend is strained to the rupture elongation of the weaker fiber, the stress in the stronger fiber is lower than the stress in the weaker fiber; hence, its contribution per unit area toward carrying the applied load is less than that of the weaker fiber. However, when the stress-strain curve of the stronger fiber is concave downward and the blend is strained to the rupture elongation of the weaker fiber, the stress in the stronger fiber is higher than the stress in the weaker fiber; hence its contribution per unit area toward carrying the applied load is greater than that of the weaker fiber.

Thus, not only the ultimate tenacity or strength of the fibers, but also the shape of their stress-strain curves must be known in order to determine which blends produce the optimum yarns.

(more Contents Noted on p 182)



Up to 1% Moly in carburizing steels gives required hardenability economically

Why limit the use of molybdenum to the .15/.25% Mo and .20/.30% Mo contents of the traditional grades? For the contributions of moly do not stop there. Laboratory tests and production runs prove that as molybdenum contents increase up to 1%, hardness increases progressively. A wide range of case and core hardenabilities, therefore, can be obtained — economically, too.

Tests with a series of molybdenum-manganese steels show that these compositions give higher case hardness on a direct quench than other steels of comparable core hardenability. One extensively tested composition, for example, is 0.5% Mo — 0.5% Mn steel. It shows longer life, and is lower in cost than steels previously used. And it produces a higher case hardness with similar or less distortion. What's more, tool life and surface finish are equal or better. Good reasons why several companies have already adopted this grade for automotive gears and other critical applications.

If you use carburizing steels, see what a higher molybdenum content can do for you. Part of the story is contained in the technical article "New Carburizing Steels For Critical Gearing." For your copy, or other technical data, write Climax Molybdenum Co., Dept. 6, 500 Fifth Avenue, New York 36, N. Y.

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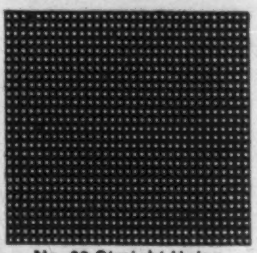
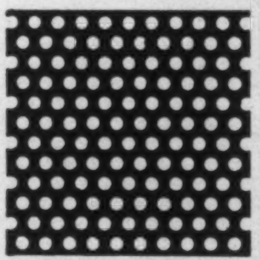


No. 00 Straight Holes
952 holes per sq. in.
.020" diam. 30% open.



.060" Staggered holes.
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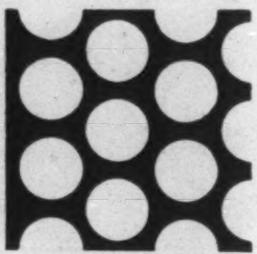
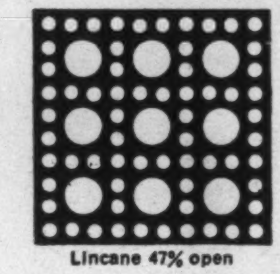


1/4" Staggered Holes.
5/16" centers.
.25" diam. 58% open.



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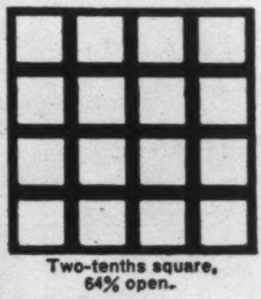

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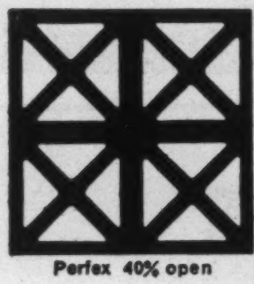

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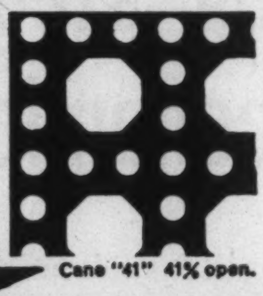

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CONTENTS NOTED

Notch Ductility of Malleable Irons

Until recently the unexpected nonductile failure of metals which show good ductility in tensile tests caused considerable confusion regarding the significance of tensile tests. It is now generally appreciated that ductility as measured by tensile tests is significant only for conditions equivalent to those of the tensile test bar.

Notch tests needed

Brittle fractures in service generally result from the presence of notches. Notches of various types are ordinarily present in structures and machinery components either as design features (notches, threads, keyways) or defects (grinding or quenching cracks, shrinkage or hot cracks in castings, weld flaws, etc.). Consequently, it is necessary to evaluate the ductility of metals not only by tensile tests but also by tests which take into account the presence of notches.

The ductility of malleable irons containing sharp notches has been investigated by G. A. Sandoz, N. C. Howells, H. F. Bishop and W. S. Pellini of the Naval Research Laboratory. Their tests and results were described in a paper presented at the 1956 convention of the American Society for Metals.

The drop weight test was used to establish nil ductility transition (NDT—the temperature below which material cannot be made to deform even slightly in the presence of a sharp notch without the development of brittle fracture). The explosion crack-starter test was applied to establish resistance to fracture propagation at temperatures above the NDT temperature.

Results of tests

1. The NDT temperature of malleable irons increases proportionately with phosphorous content. With very low phosphorous contents (below 0.03%) the NDT temperatures are below—150 F; with high phosphorous contents (0.20%) transition temperatures are on the order of 0 F.

2. Presence of up to 0.2% sulfur, in the presence of sufficient manganese to effect a combination, has no effect on the NDT temperature. Sulfur, however, lowers the energy level of the upper shelf of the Charpy curve which makes the iron less resistant to tearing (shear) type fractures.

3. Notch ductility of ferritic malleable irons is insensitive to section size provided the composition of the iron and/or ladle treatment of the melt is such that primary graphitization is prevented. Well made commercial ferritic irons have NDT temperatures on the order of -50 F in section sizes

PROPERTIES OF MALLEABLE IRONS

Composition, % C	Si	Mn	P	S	Ten Str, 1000 psi	Elong, %	NDT (cast surface), F	NDT (mach surface), F
2.13	0.92	0.22	.015	0.02	55	15.7	−10	–
2.13	0.92	0.22	.115	0.02	52	12.5	+20	–
2.13	0.92	0.22	.176	0.02	60	14.0	+70	–
2.13	0.92	0.22	.207	0.02	68	14.5	+90	–
2.09	1.01	0.13	.007	0.024	46	22.0	–	−150
2.09	1.01	0.21	.006	0.055	44	23.0	–	−150
2.09	1.01	0.29	.006	0.103	45	22.0	–	−150
2.09	1.01	0.38	.006	0.150	46	19.0	–	−150
2.09	1.01	0.51	.006	0.200	46	20.0	–	−150
2.08	1.04	0.27	.01	0.024	44	21.5	−120	–
2.08	1.04	0.27	.05	0.024	46	22.5	−90	−140
2.08	1.04	0.27	.12	0.024	48	20.5	−60	−70
2.08	1.04	0.27	.24	0.024	55	21.0	+30	+20

Photo Courtesy of Z & W Machine Products, Inc.

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CONTENTS NOTED

up to 3 in. thick bars.

4. Notch ductility of pearlitic irons appears to be highly sensitive to the type of heat treatment. Pearlitic malleable irons of the reheat treated and air quenched and tempered type having Brinell hardness values in the range of 160 to 190 develop NDT temperatures between 10 and 70 F. These values are characteristic of specimens from which the decarburized surface layers have been removed. With the decarburized surface present, NDT temperatures are generally raised approximately 20 F.

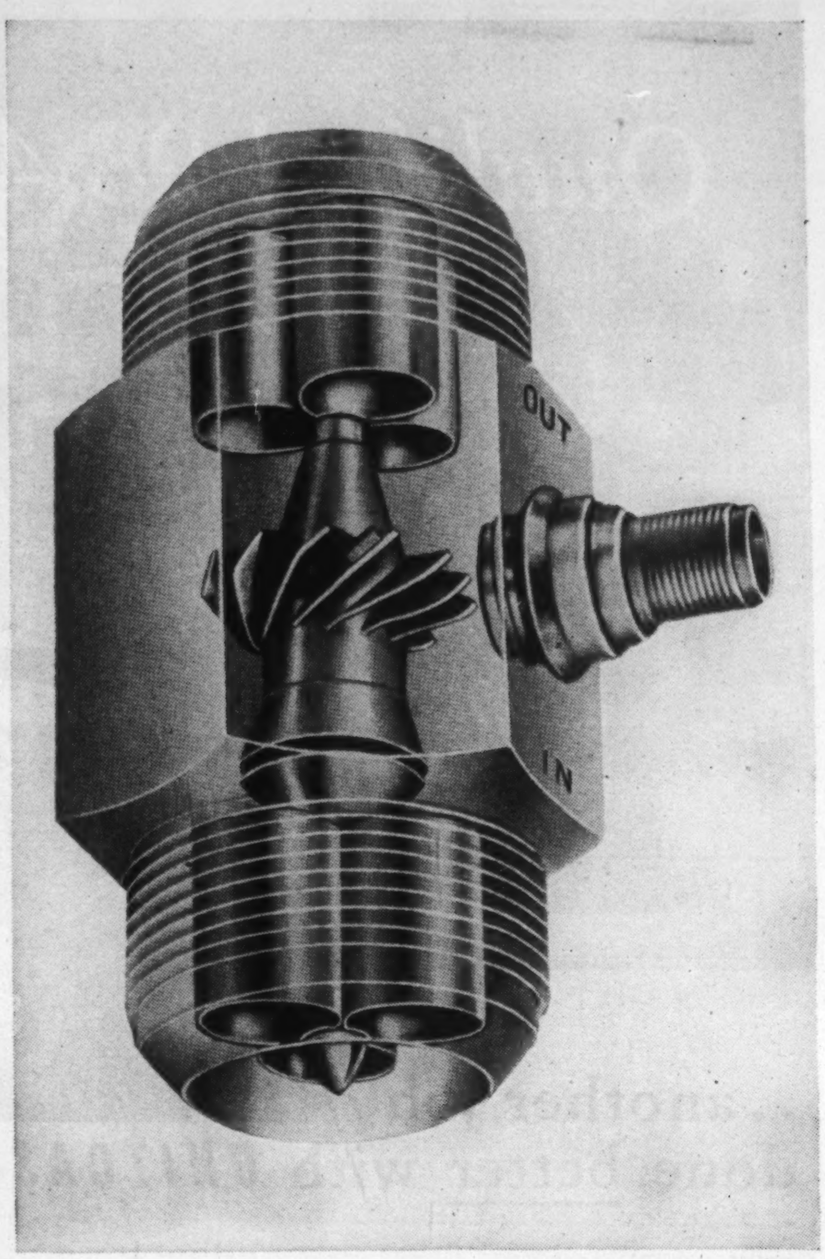
5. There is good correlation in malleable irons between NDT temperatures and Charpy V notch energy transition curves. The NDT occurs at the temperature where the Charpy V energy values are 3 to 6 ft-lb (lower toe region of transition curve).

6. Explosion crack starter tests show that brittle fractures may be forced to occur at temperatures above the NDT only if severe deformation is developed. At temperatures approximately 50 F above the NDT temperature, the propagation of brittle fracture becomes difficult to the extent that complete fracture of the test plate is no longer obtained.

7. The relatively low maximum energy values of malleable irons in Charpy V notch tests have no relationship to the development of brittle fracture. These low values of energy for ductile failure in the Charpy test signify that the material may be ruptured in shear with relatively low energy absorption if excessively high overloads are developed.

Evaluating Vinyls as Metal Finishes

The effectiveness of vinyl films in providing durable, abrasion and chemical resistant coatings for metals has been demonstrated in a variety of applications. At a recent meeting of the American



Designing parts from *Carpenter* Stainless No. 20 helps tame corrosive rocket fuels

Internal parts of "flow sensing" units which control the flow of fuel to rocket engines, must combine super corrosion resistance and mechanical durability. They meter liquid oxygen at —297°F and a 90-98% concentration of red fuming nitric acid. That's why these critical parts were designed with the super corrosion resistance of Carpenter Stainless No. 20, and machined from No. 20 bar stock.

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CONTENTS NOTED

Society for Testing Materials, C. I. Spessard, of Bakelite Co., summarized a number of methods by which vinyl coatings can be evaluated and their in-service performance improved.

Adhesion—Inadequate adhesion of vinyl coatings is one of the most common sources of film failure. This condition is generally caused by unclean surfaces at the time of application or by subsequent exposure during service. Oil, grease, soot, grime, soil and oxides must be removed before application, or else they will interfere with the film-to-metal bond. Proper selection of resin is particularly important. A maleic-modified resin, a vinyl butyral wash primer (normally top-coated with a hydrolyzed vinyl chloride resin), or a primer based on a hydrolyzed vinyl chloride resin will greatly improve adhesion, particularly for air-dried coatings.

Underfilm corrosion—This form of corrosion—probably the biggest cause of loss of adhesion of vinyl films during service—can result from pinholes, direct permeation, breaks or cuts. The best way to prevent underfilm corrosion is to use one of the vinyl butyral resin-based wash primers. A wash primer, however, is an extremely thin coating and is not intended to be the sole protective film. For superior resistance, it is advisable to apply successive coatings based on special vinyl resins intended for use over the corrosion-inhibiting coat.

Pinholes can be easily detected by any one of a number of instruments specifically made for this purpose. Use of multiple coatings is the best insurance against pinhole attack, since the chance that two pinholes will line up is very small.

Some gases and liquids, such as ammonia, carbon dioxide and dilute acetic acid, do not harm a vinyl film directly, but are capable of passing through the film in varying degrees. In the presence of a small amount of moisture, these materials can cause corro-

Craig Helicop-Hut* made strong, light, shock-resistant with LOCKFOAM

Craig Systems, Inc., makes many transportable units that carry highly sensitive electronic instruments, optical equipment—even guided missiles. Naturally, they give most careful thought to the materials they use.

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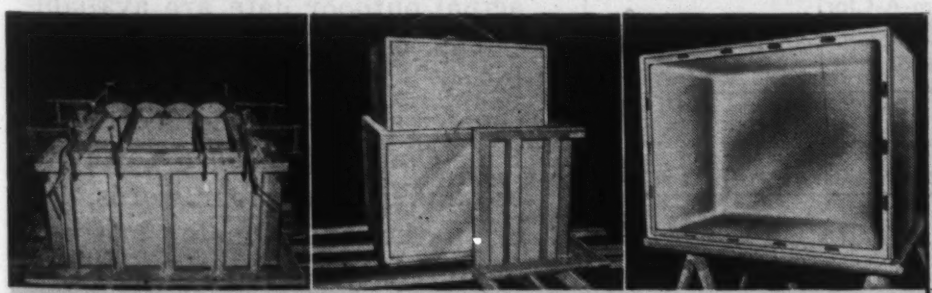

SIMPLICITY OF CONSTRUCTION. From left to right, the photographs show (1) how the Lockfoam is poured between the aluminum skins, where it expands and solidifies in minutes; (2) removing the mold; (3) the completed structure, ready to give rugged service for years.

Some Uses of NOPCO LOCKFOAM

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Strength: Panel Construction of Trailer Trucks

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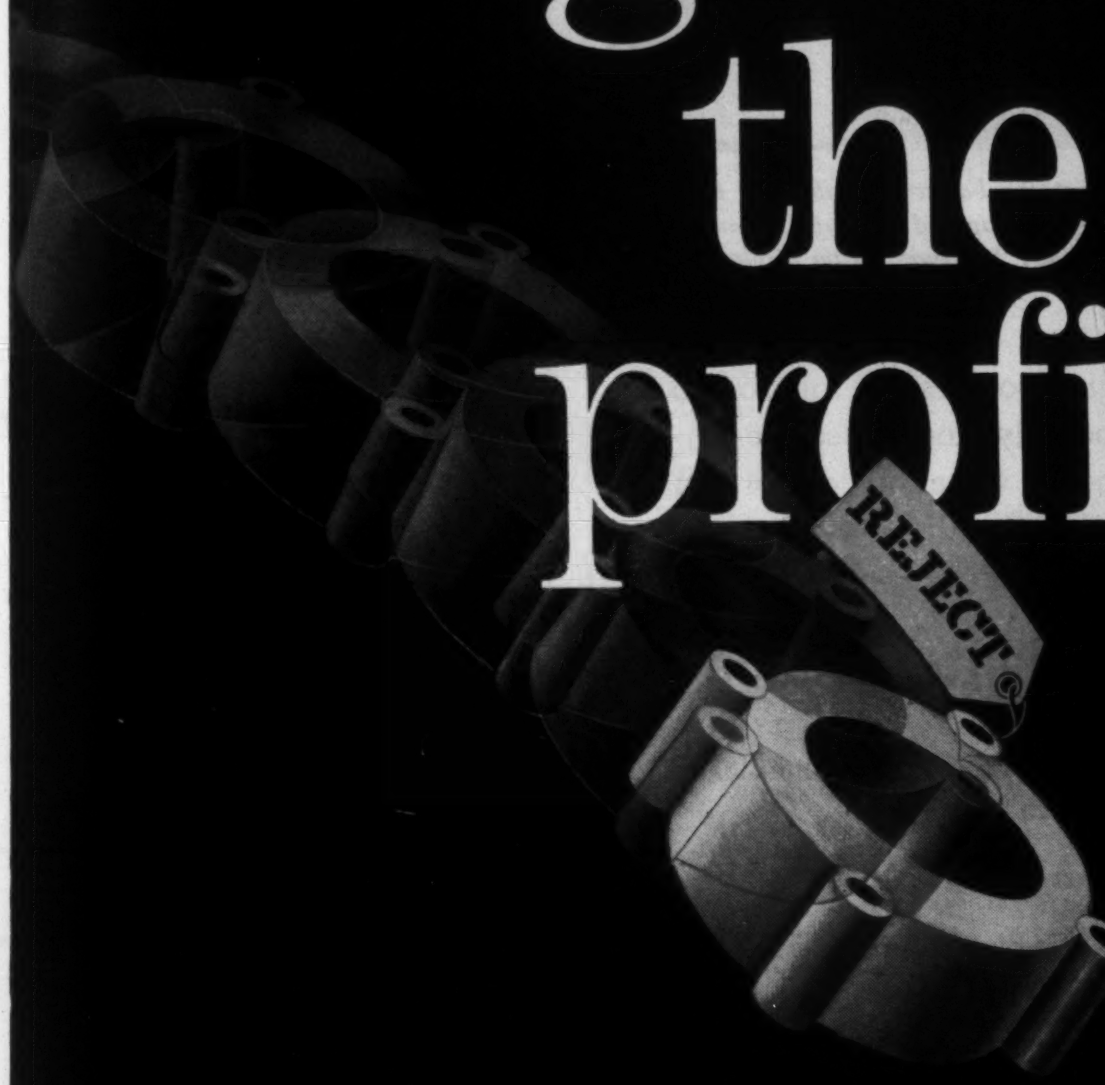
sion beneath the unaffected film. This effect is particularly noticeable at high temperatures due to the increased vapor permeability of the vinyl film. Use of high molecular weight resins, particularly the dispersion grades, reduces the permeability of vinyl films. Baked films offer better permeability to carbon dioxide. The problem of ammonia permeability has not yet been solved.

Fading and weathering—Because of the large number of outdoor applications, the exterior performance of vinyl metal finishes is particularly important. Light degradation is one of the weaknesses of vinyl coatings out of doors. However, with the proper pigmentation, vinyl coatings are among the best exterior finishes known. Pigments can be selected that are capable of screening out ultraviolet light that is injurious to vinyl resins. Unpigmented and clear vinyl coatings are more sensitive to degradation than most coating materials. They are unsuitable for exterior use since they blacken and degrade rapidly and have a service life of no longer than two months.

In evaluating pigmented vinyl coatings for exterior use, actual exposure tests are often impractical because of the time it takes for any sign of failure to develop. Correlation between outdoor tests and data from accelerated testing machines is significant. Correlation is usually not perfect, however, and there are exceptions that are far out of line. Consequently, acceleration tests should be used only on a temporary basis until actual outdoor data are available.

The correlation coefficient between a modified X1A Weather-Ometer and an unmodified FDA-R Fade-Ometer has been calculated to be 0.757. In other words, 1.44 hr in the Fade-Ometer has been found equivalent to 1.0 hr in the X1A unit. For rating changes in vinyl coloring materials, both machines show good correlation with outdoor tests performed in New Jersey and Florida. In rating film

there goes the profit...



use of impure ammonia for metal treating is a frequent cause of discoloration on finished parts

The ammonia you use for metal treating can add to your profits—or reduce them! Impurities like oil or moisture may cause discolorations that land finished work in the salvage box. They are also a common cause of poisoned catalysts and other costly dissociator troubles.

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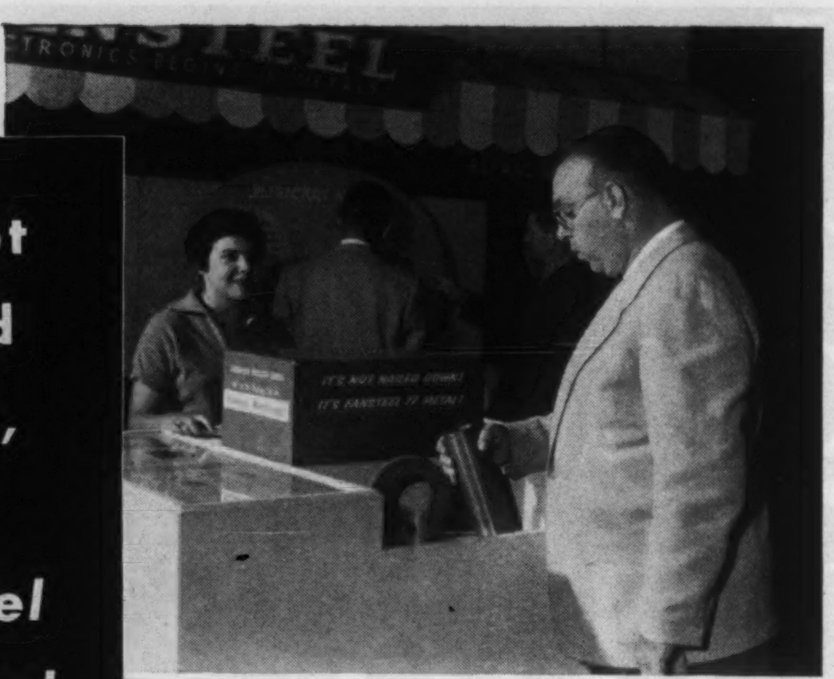

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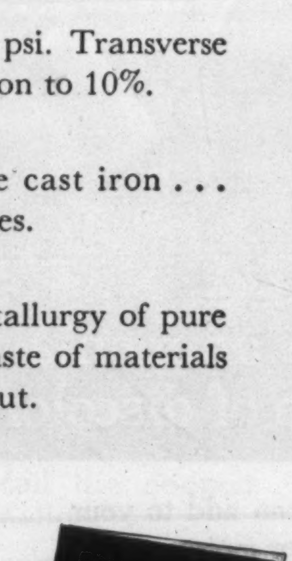

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K565A

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CONTENTS NOTED

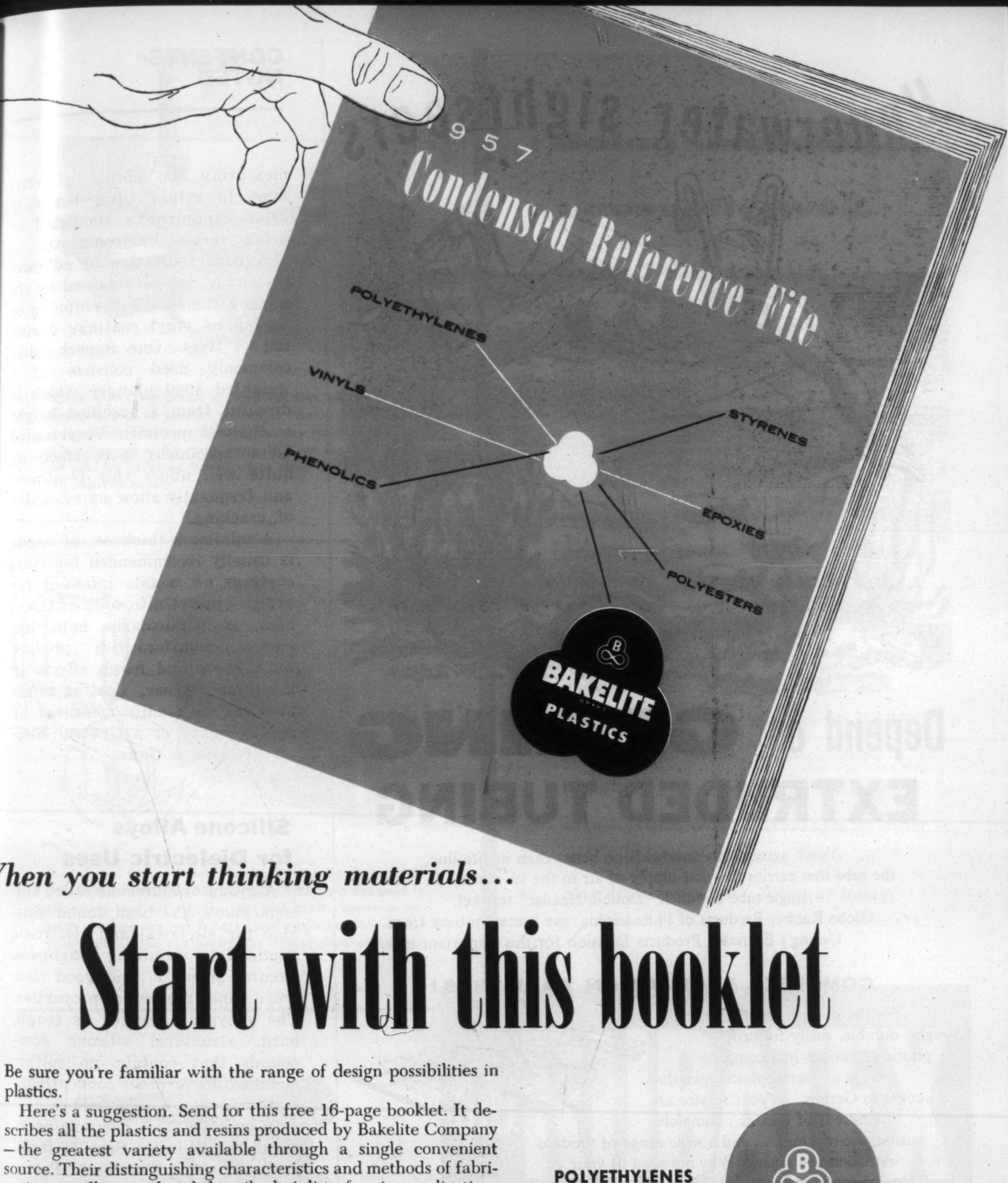
decomposition, however, correlation between outdoor and accelerated data was not as good and in some cases did not exist at all.

Moisture resistance—Exposure of vinyl-coated specimens in a humidity cabinet is one of the most useful and severest tests for evaluating moisture resistance. This test is capable of producing failure of many conventional coating systems in a week to a month. Properly formulated vinyl systems should hold up from one to two years. Vinyl coatings should also be expected to hold up for many months or even years after immersion tests in both salt and fresh water.

Chemical resistance — Because vinyl coatings are impervious to strong alkalies and mineral acids, it is seldom necessary to test the resistance of coatings to these chemicals. To evaluate formula changes, however, a simple beaker test can be performed which gives an excellent indication of actual service results. Because of the danger of softening the vinyl film, the test should not be accelerated by raising the bath temperature. Testing at room temperature insures good reproducibility and correlation of results. Acid tests can also be used to rate coating homogeneity.

Physical failure—Physical toughness and abrasion resistance of vinyl coatings can be improved by using the higher molecular weight resins. Measurements of abrasion resistance obtained with a Taber Abrader should be used with caution, as the values are influenced by the heat generated during the rubbing action and by abrasive particles that may become imbedded in the coating. In one abrasion test cited, a vinyl dispersion coating showed little signs of wear after 4000 revolutions as compared to a conventional baked coat which wore out after only 528 cycles.

Distensibility of vinyl coatings is usually determined by bending panels over a conical mandrel. The test is particularly useful in



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Here's a suggestion. Send for this free 16-page booklet. It describes all the plastics and resins produced by Bakelite Company – the greatest variety available through a single convenient source. Their distinguishing characteristics and methods of fabrication are illustrated and described. A list of major applications tells where each is being used.

The 1957 Condensed Reference File gives you a quick survey of the most widely used plastics and resins. Other Bakelite Company publications, also available without cost, will provide additional technical data on the material you decide is best suited to your needs. And Bakelite Company technical representatives, backed by more than 46 years' experience in plastics, will help in applying it to your product. Write Dept. VX-108.

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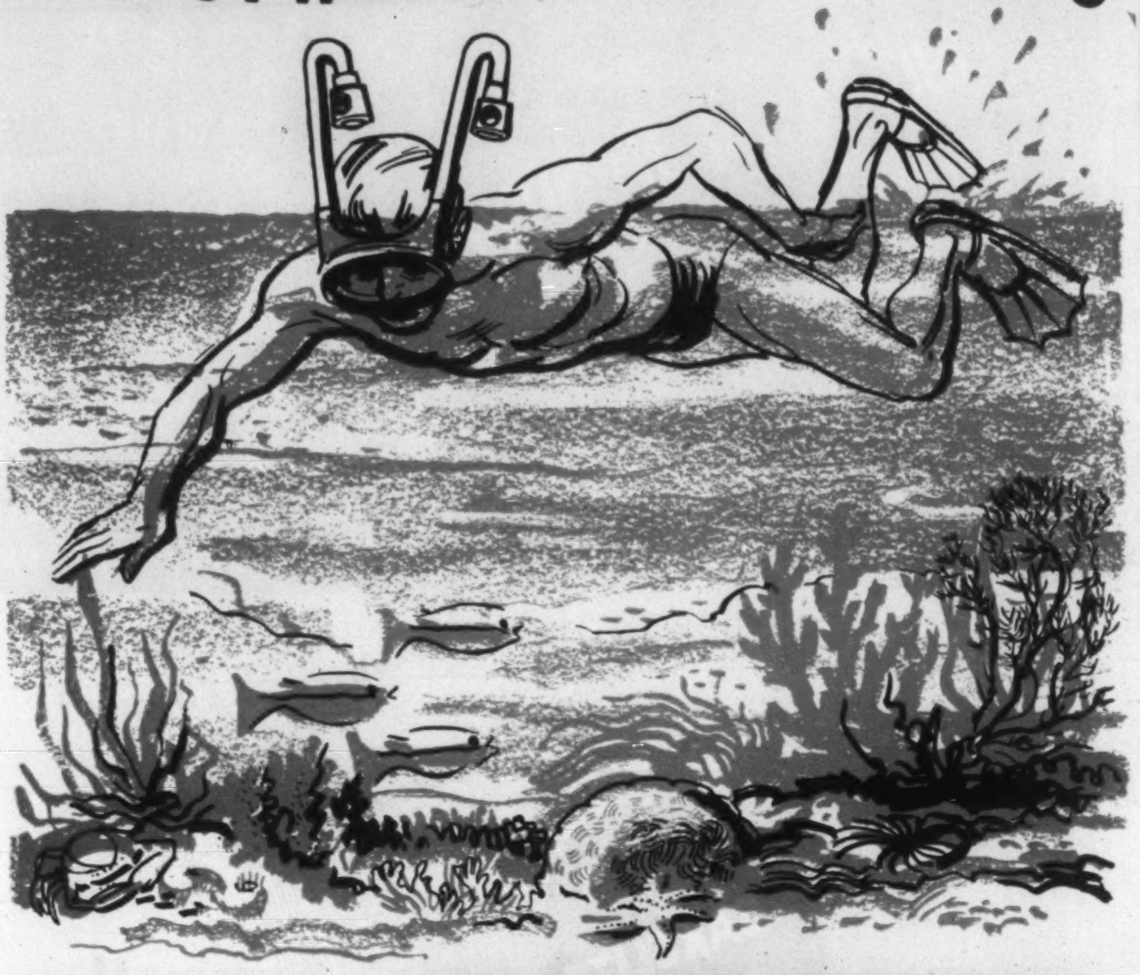
Underwater sightseers



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You'll agree that a snorkel is no better than its life-line, the tube that carries the vital supply of air to the swimmer. In both their single-tube and their "Double-Header" snorkel, Globe Rubber Products of Philadelphia, use acetate tubing from Gering's Extruded Products Division for this important task.

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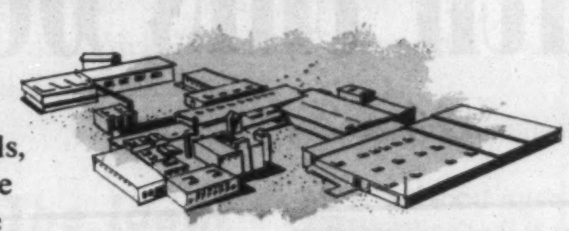

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measuring the ability of vinyl films to retain their flexibility after exposure to simulated or actual service environments.

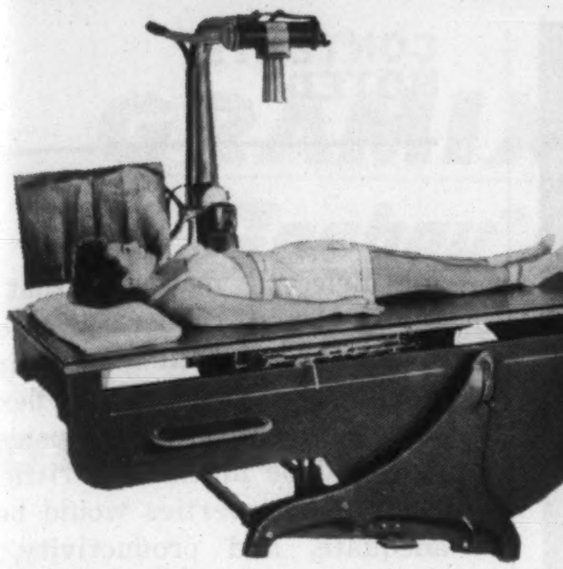
A good indication of adhesive properties can be obtained by observing the extent of chipping or flaking of vinyl coatings during impact tests. One impact tester commonly used consists of a weighted steel plunger which is dropped from a specified height on the test specimen. Vinyl coated metal specimens have stood up quite well under this treatment and frequently show no evidences of cracking.

A minimum thickness of 5 mils is usually recommended for vinyl coatings on metals intended for exterior use. Uniformity of thickness is particularly important since nonuniformities produce weak spots and notch effects in the thinner areas. Coating thickness can be readily measured by a Magnegage or a General Electric Thickness Gage.

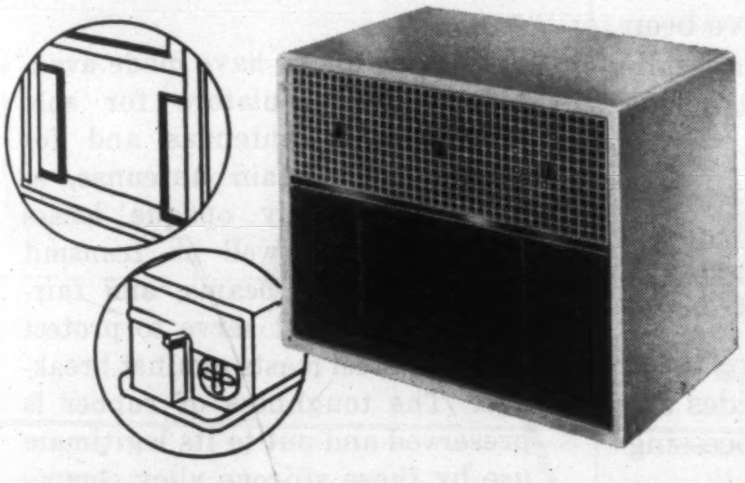
Silicone Alloys for Dielectric Uses

A group of materials called silicone alloys has been found suitable for electrical and electronic applications requiring toughness, flexural strength, and good electrical and dielectric properties. The alloys are defined as tough, hard, structural silicone compounds that contain no sulfur, metal oxides or other conventional curing agents or accelerators.

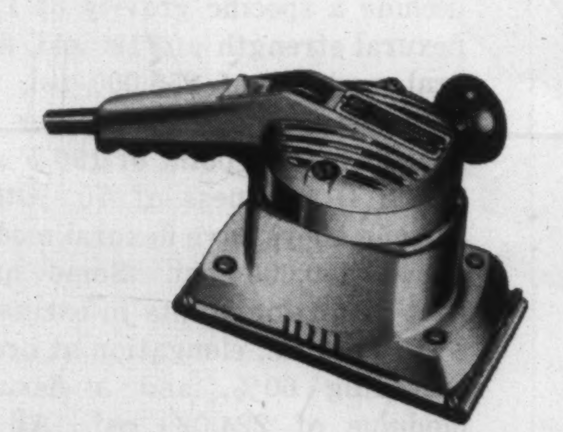
Discussing these new engineering materials in the Sept '56 issue of *Rubber Age*, Charles L. Petze, Jr., of Delaware Research, says that silicone compositions embodying rubber to obtain toughness have provided excellent materials for exposed electrical, electronic and structural applications, some of which have involved repeated immersion to substantial depths of sea water, as well as long exposure to wind and sun. For such applications it was obvious from the specific properties required



PICKER X-RAY equipment showing Rubatex as soft resilient cushioning pad to support patient in comfort during x-ray examinations. Highly radiolucent, Rubatex makes no perceptible difference in the radiograph. Will not soak up barium salt solutions or other fluids—wipes clean with damp cloth and needs no cover.



The Rubatex Closed Cellular Rubber gaskets applied in 1956 **G.E. THIN LINE ROOM AIR CONDITIONERS** are designed to effectively seal out moisture, dirt and drafts. Shown in cut-away drawing are two Rubatex seal gaskets on the window closure panel and one behind the control plate of the unit.



Rubatex pad oscillates on base of **PORTABLE ELECTRIC TOOL's** industrial sanding unit. Reduces vibration to minimum. Resists deterioration from solvents used in industrial sanding jobs.

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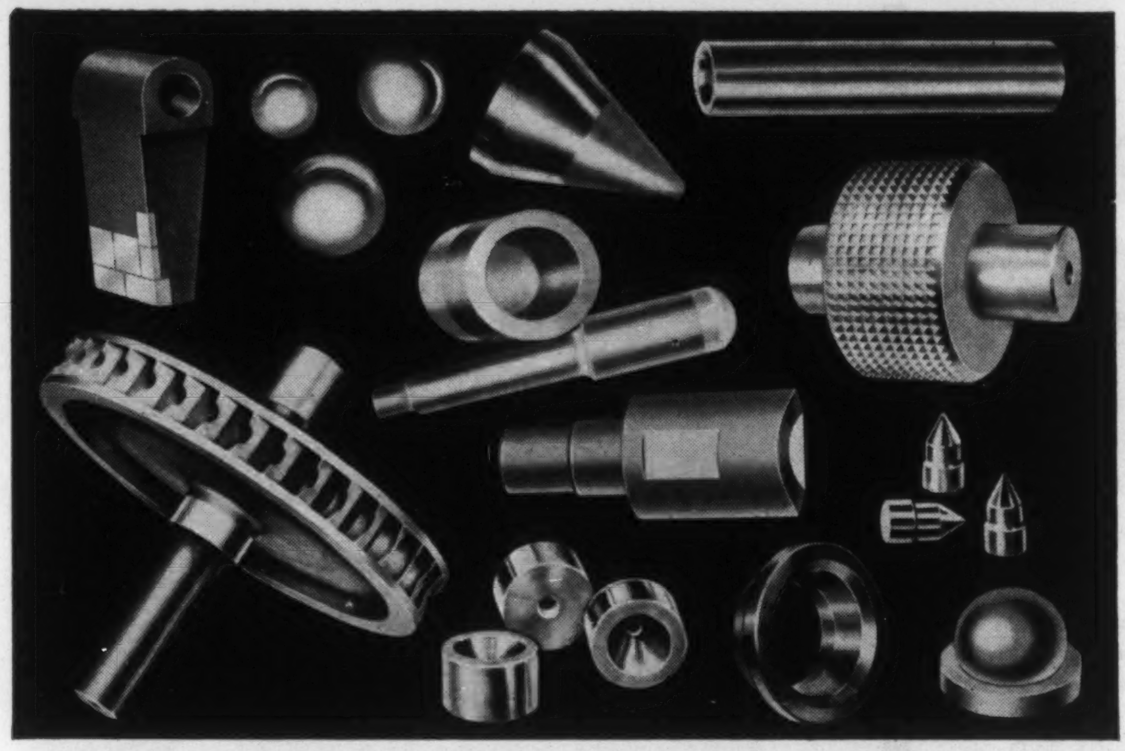

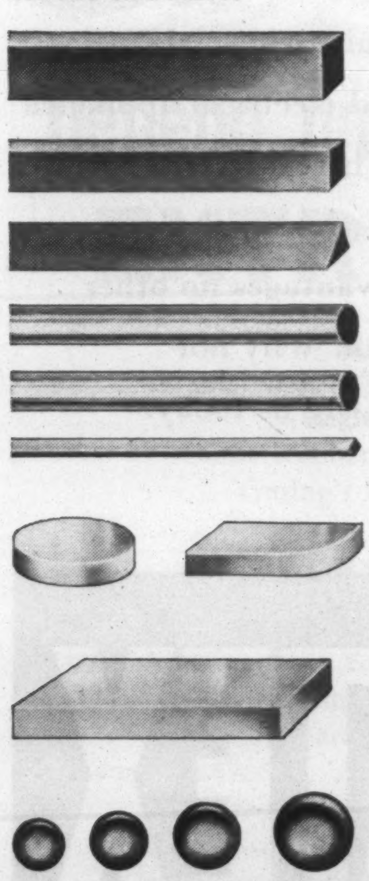

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Some of the many applications where these hard, strong and rigid sintered carbides are particularly effective in chemical processing include:

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Kennametal is available in many standard forms, in addition to special shapes and parts, such as: rectangular blanks • discs • rods • tubes • flats • balls • rings • extruded, pressed, machined, and ground forms within precise tolerances.

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for dielectric materials that sulfur-hardened rubber, despite its low water absorption, good dimensional stability and high flexural strength, could not be considered. It would be much too brittle, its dielectric properties would be inadequate, and productivity, per man hour and per machine hour, for finished products made of it would be far too low. It was equally obvious, for differing reasons in each case, that none of the known rigid, nonrubber compounds, rubber-resin blends or conventional rubber compounding practices could be used successfully.

Properties

Silicone alloys have made available better insulators for submarine whip antennas and for broad-band curtain antennas, as well as optically opaque lenses that direct as well as transmit electromagnetic beams, and fairing sections that serve to protect stainless steel masts against breakage. The toughness of rubber is preserved and put to its legitimate use by these silicone alloy compositions, which are characterized by high values of flexural modulus, electrical and dielectric properties; rapid processibility, easy machinability, and stability upon continued exposure to severe service conditions.

Physical properties of one alloy include a specific gravity of 1.06, flexural strength of 7190 psi, flexural modulus of 255,000 psi, impact strength of 6.8 ft-lb per in., heat distortion point of 190 F and Shore D hardness of 70. Other silicone alloys have flexural moduli above 450,000 psi. Some have heat distortion points in excess of 8 ft-lb per in., elongation at break exceeding 60%, and a flexural modulus of 224,000 psi. All of them can be processed into end products at high productivity rates, for none requires curing.

Applications

An interesting structural application of one of the materials is a large dome having a wall thick-

GRAMIX® vanes in Gasboy® pump wear only .031" per ONE MILLION GALLONS

The Gasboy Super "200" gasoline pump is manufactured exclusively for farms, fleets, and industry by Wm. M. Wilson's Sons, Inc. in Lansdale, Pa. These pumps have proven to be accurate, efficient and dependable. But, what naturally interests us and will interest you, as a manufacturer or designer, are the GRAMIX vanes in these pumps. Tests reveal that the GRAMIX Grade 41 vanes still operated perfectly after pumping over 1,000,000 gallons of gasoline. During this endurance test, the vanes travelled around the inside of the housing a distance equal to 13,000 miles, or more than half way around the earth!

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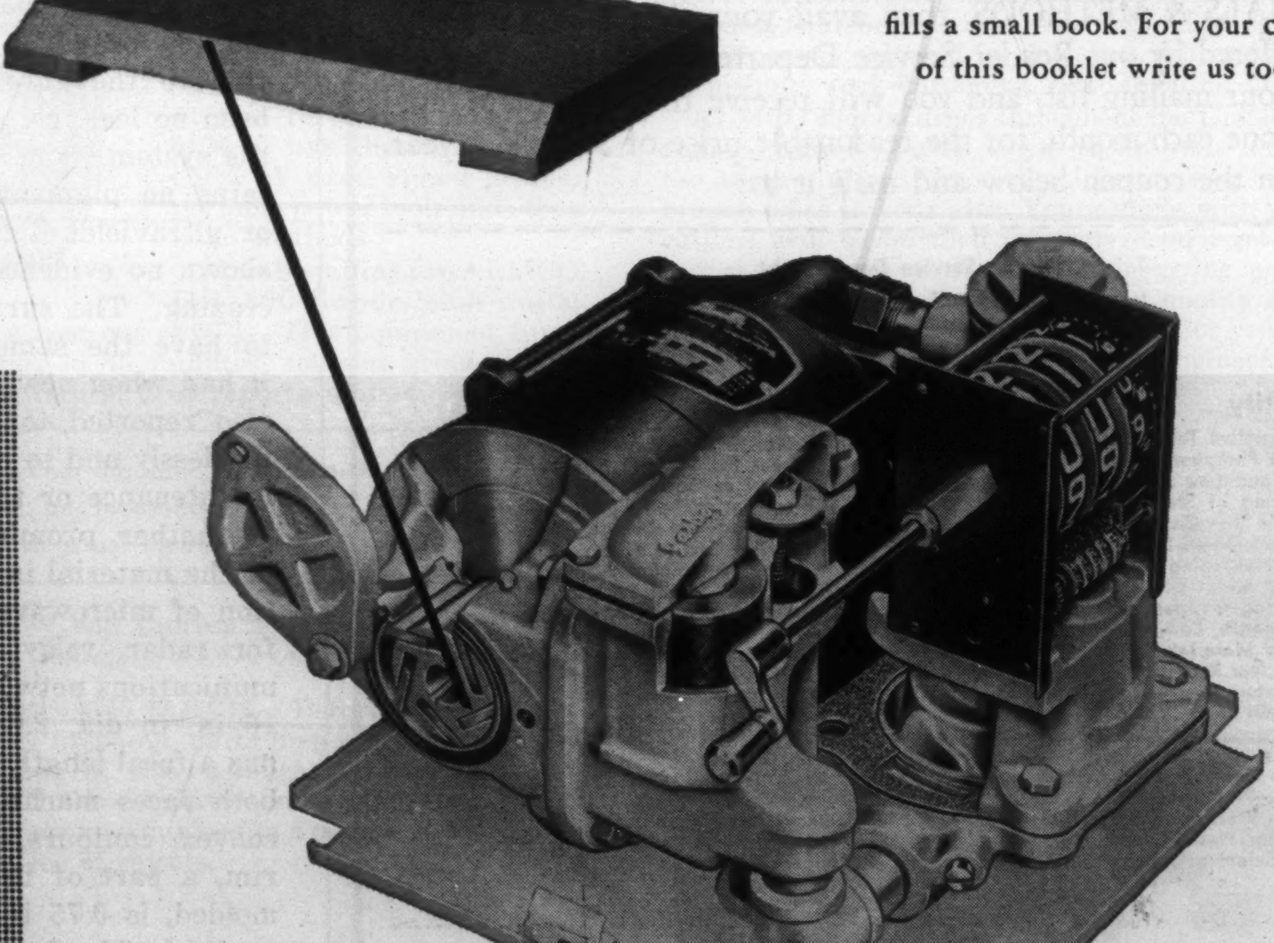

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ness varying more than eight-fold and a gross weight of about 60 lb. The dome was designed by the Underwater Sound Laboratory to house multi-band omnidirectional microwave antennas. Mounted outboard on a submarine, the dome must protect the electronic system against external forces and infiltration of sea water even when submerged to great depths and when subjected to severe shock stresses, and must provide for proper transmission at different microwave frequencies for the full 360 deg of azimuth.

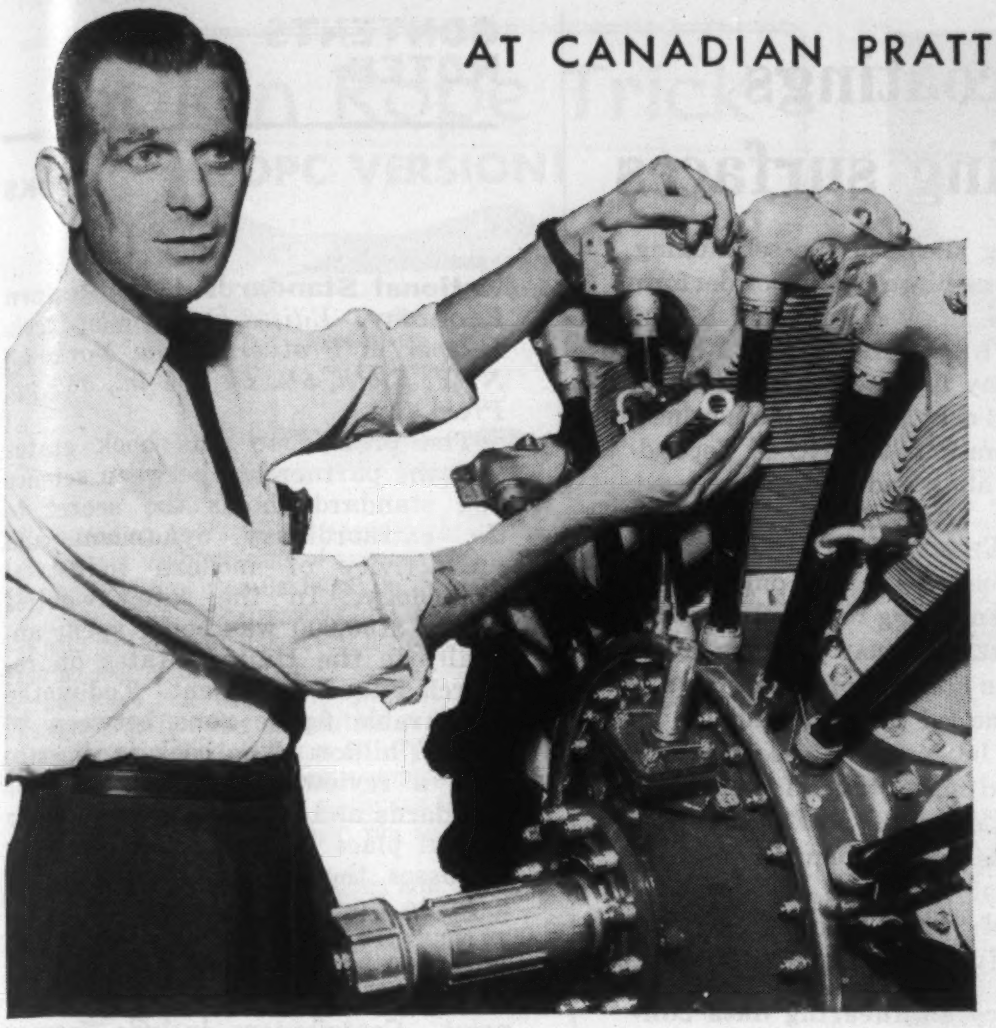
Silicone alloy domes have been found to transmit the required beam patterns to maintain their dielectric properties, and to remain completely dimensionally stable from —40 to 150 F.

A silicone alloy dome in use on a modern submarine since Mar '55, has provided complete protection to the antenna. There has been no leakage of sea water into the system. The alloy, which contains no pigment or antioxidant or ultraviolet light absorber, has shown no evidence of cracking or crazing. The surface is reported to have the same characteristics it had when new. The antenna is also reported to have performed flawlessly and to have required no maintenance or repair.

Another promising application of the material is in the construction of microwave antenna lenses for radar, relay links and communications networks. The lens is 16 in. in dia, 2.28 in. thick, and has a focal length of 22.4 in., with both faces machined to differing convex contours. The mounting rim, a part of the lens blank as molded, is 0.75 in. wide and 0.50 in. thick. The finished lens weighs approximately 11 lb. It was found that silicone alloys machine well and void-free thick sheets are produced quickly and easily. In addition, beam pattern determinations at 34,900 mc proved that the material was homogeneous and isotropic throughout.

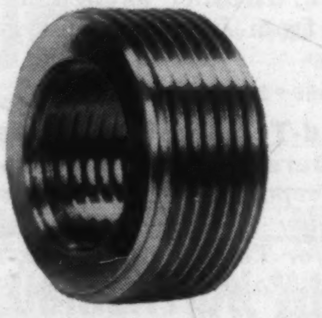
(Books on p 198)

AT CANADIAN PRATT AND WHITNEY AIRCRAFT...



ALMCO barrel finishing SAVES 97% on deburring and finishing of spark plug bushings

◀ **CUTS DEBURRING AND FINISHING COSTS $2,430** — Threaded spark plug bushings used in famous Pratt & Whitney aircraft engines will be deburred and finished for $2,430 less this year with Almco equipment and processes. Maurice Harrison, Supervisor of Process Planning, shows the small part on which this savings will be made.



● **SAVES .10125 ON EACH BUSHING**—Deburring and finishing threaded spark plug bushings like the one shown at the left, formerly cost $104.20 per thousand when CP & W used speed lathes, portable power tools and other hand methods.

After installing two ALMCO DB-200 Supersheen units, records showed a cost cut of 97%. This equipment turns out 1,000 bushings in 45 minutes, releases grinders and finishers to other duties. Cost reports showed:

$104.20	cost per thousand with power tools.
2.95	cost per thousand with 2 ALMCO barrels.
$101.25	Savings per thousand pieces.

This year CP & W will process 24,000 spark plug bushings, *with a total savings of $2,430 on this one part alone.*

PRACTICALLY ELIMINATES REJECTS—Before installing controlled-type barrel finishing, parts inspectors returned for re-work an average of 125 bushings out of every 1,000 (12½%). With Almco Supersheen equipment and processes, these parts are now finished to a degree of uniformity that is virtually free of rejects.

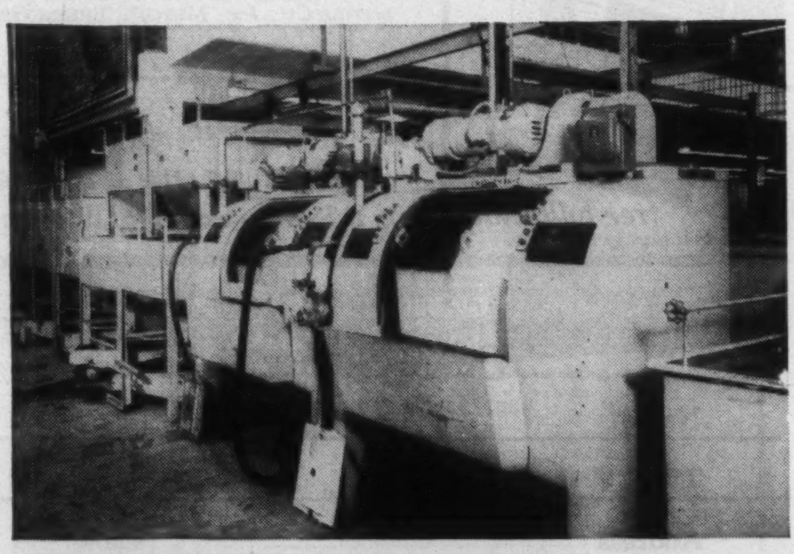
DESIGNED FOR MANY METAL FINISHING OPERATIONS—In addition to deburring and finishing, ALMCO equipment and processes are used for descaling, degreasing, grinding, burnishing, work-hardening, rust-inhibiting, polishing, etc.

ALMCO has facilities throughout the United States for running sample parts. Write us on your letterhead for the address of an Almco sample processing laboratory or branch office in your area. Your sample, with your specifications, will be handled promptly. You'll get a complete report on where you can save deburring and finishing costs, how you can improve product quality and appearance, and what method and unit is best for your operation. Or, if you prefer, ask an Almco sales engineer to call you.

SEND FOR FREE 52-PAGE BOOK

Full of facts and processes on barrel finishing. Includes detailed cost chart on finishing of typical parts. Send for your copy today.

Supersheen
BARREL FINISHING



Two Model DB-200 Almco machines, using Supersheen bonded abrasive chips and compounds, deburr and polish 1,000 spark plug bushings in 45 minutes at Canadian Pratt and Whitney.

ALMCO

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Tough, hard ceramic coatings provide superior bearing surfaces

Sprayed alumina forms "sapphire-hard" surfaces highly resistant to wear, abrasion and corrosion. Ideal for bearing surfaces, seals.

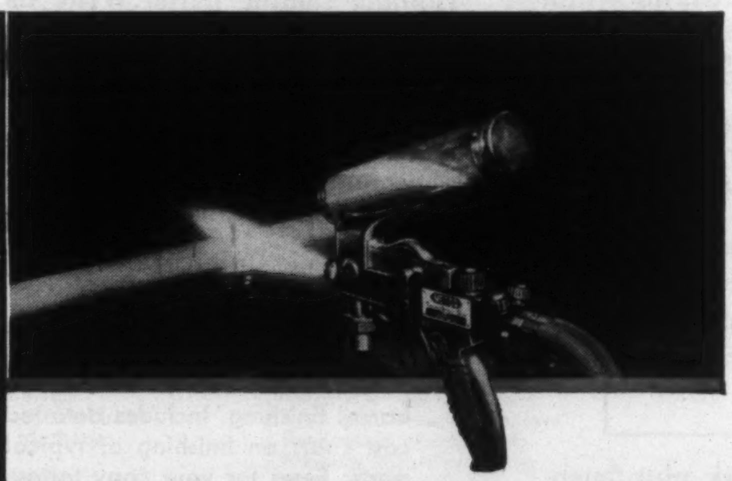
Development of the new METCO THERMOSPRAY GUN for spraying high-melting-point ceramic materials at low cost opens up a variety of new practical applications. One that has produced a great deal of interest is the use of sprayed alumina coatings for bearing surfaces and mechanical seals. This THERMOSPRAY 101 Ceramic Powder produces surfaces with a hardness of 9.0 on the Moh scale, (only the diamond rates 10.0) with excellent resistance to wear, abrasion and corrosion. When used in combination with special phenolic or furane plastic sealers it provides superior protection against many acids.

Another THERMOSPRAY Powder – 201 – is zirconia which is somewhat softer than No. 101 but provides superior heat-insulating properties. Melting point of this material is 4600° F. and particle hardness 8.0 on the Moh scale.

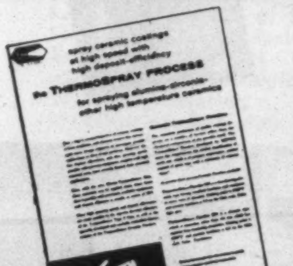
Hard-facing alloys of the self-fluxing, nickel-boron-silicon type in powder form can also be applied with the METCO Type P THERMOSPRAY GUN. These coatings may be fused, semi-fused, or left unfused depending on the hardness desired, from RC 30 to RC 65, depending on the alloy and the process used.

The new THERMOSPRAY GUN operates without compressed air, only oxygen and acetylene being required. The free-flowing THERMOSPRAY powders are fed to the flame nozzle from a hopper atop the gun, melted and propelled to the surface to be coated. These materials are sprayed many times faster (up to 15 sq. ft. per hour–.010" thick) than has been possible with equipment previously available. Deposit efficiencies are in excess of 95%. These factors result in extremely low coating costs.

Preliminary engineering data contained in Bulletin 127 covers ceramic coatings while Bulletin 126 covers the hard-facing alloys. Either or both may be obtained by filling out the coupon below or writing on your company's letterhead. No obligation, of course.



Pump rod sprayed with alumina provides superior protection against abrasion and corrosion.



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Please send me ☐ free Bulletin 127 (ceramic coatings)
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BOOKS

National Standards in a Modern Economy. *Edited by Dickson Reck. Harper & Brothers, New York 16, N. Y. Cloth, 6¼ by 9½ in., 380 pp. Price $5.*

The preface to this book states that the partnership between science and standards holds the secret to the extraordinary dynamism and productivity of modern industrial technology. In the late twenties nearly $100,000 was being spent annually in the United States on research and development. Today the comparable figure runs between $6 and $8 billion. The book is at once both a review of the evolution of standards and an evaluation of their crucial place in the world today. It discusses the application of standards to industry, government and agriculture and points out some implications of their use from both a national and international standpoint. Contributors include former President Herbert Hoover and Walter P. Reuther as well as other leaders from industry and government.

Elevated-Temperature Properties of Coppers and Copper-Base Alloys. *Prepared by Clair Upthegrove and Henry L. Burghoff. American Society for Testing Materials, Philadelphia 3, Pa. Paper, 248 pp., 8½ by 11 in. Price $5.50.*

Primarily a graphical summary of elevated temperature data for coppers and copper-base alloys. Data for the coppers are limited to the wrought materials, whereas data for the alloys apply to cast and wrought materials. Graphical data includes modulus of elasticity, tensile strength, yield strength, reduction of area, elongation and stresses for rupture from 100 to 100,000 hr. Data sheets giving the original data on which the curves are based are included in the appendix. Data sheets also give chemical composition, shape, size and processing information for each specific material.

Symposium on Impact Testing. *American Society for Testing Materials, Philadelphia 3, Pa. Paper, 6 by 9 in., 170 pp. Price $3.50*

This publication is based on a series of papers given at a recent symposium on impact testing sponsored by the ASTM. The various papers discuss and evaluate impact and shock tests for parts, components and complete structures.

Subjects discussed in the book are: a method of testing shipping containers for the longitudinal shocks en-

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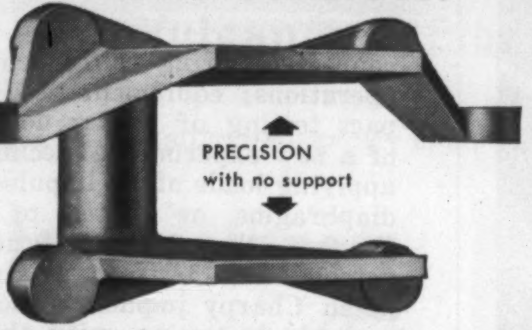
Indian Rope Trick

OPC VERSION!



Those Indian fakirs who suspend ropes in the air without visible means of support have nothing on Ohio Precision Castings! On this aluminum casting, an extremely close tolerance is held between two planes—at the unsupported end of the casting.

But there's no trick to it—difficult assignments like this are routine at OPC. Maintaining close tolerances on intricately detailed work, and providing a smooth finish that eliminates all or most machining time, are yours automatically when you specify OPC castings.

Our illustrated brochure shows how it's done and includes several interesting examples of small parts production savings in many industries. May we send you a copy?

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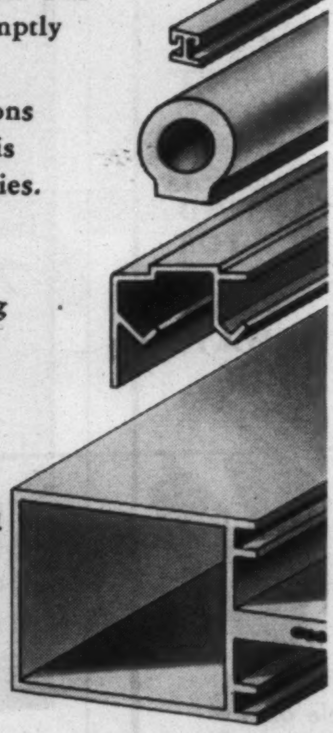
PE engineers have wide experience in all types of fabricating operations and can provide invaluable aid in helping create new aluminum extrusion applications that will cut manufacturing costs and improve product quality. Your inquiries receive personalized and confidential attention.



Write for Free Copies PE Extrusioneering News
New illustrated bulletin covers case studies of cost-cutting extrusion applications, includes helpful technical data for design engineers and purchasing executives and gives further facts on PE facilities.

SIMPLE, COMPLEX — LARGE OR SMALL
You'll find PE thoroughly experienced and well equipped to produce almost any type or size extrusion to serve your needs. There are over 5 000 standard PE shapes to select from—without a die service charge. PE Extrusioneering provides the answer for especially designed shapes.

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Chicagoland's Oldest Aluminum Extruder

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CONTENTS NOTED

BOOKS

countered during railroad switching operations; equipment used for impact testing of yarns; development of a new experimental technique for applying loads of an impulse type to diaphragms or plates of various shapes; theory and practice of notched bar testing; study of V-notch Charpy impact vs slow bend; and shock testing with the rocket powered pendulum.

The book contains charts, graphs and photographs to illustrate the various impact tests. It contains several bibliographies of impact testing.

Aircraft Materials and Processes: 5th Ed. *George F. Titterton. Pitman Publishing Corp., New York 36, N. Y. 1956. Cloth, 6¼ x 9¼ in., 310 pp. Price $6*

Based largely upon a series of lectures given by the author at New York University, this book presents in one volume essential information on materials and processes used in the construction of aircraft.

The book gives properties, uses and aircraft specifications for such materials as titanium, corrosion resisting steels, nickel alloys, copper alloys, wrought aluminum alloys, wood and glue, fabrics and dope, plastics, transparent materials, and natural and synthetic rubber.

Other chapters deal with heat treating, surface hardening, shaping of metal, high temperature problems, selection of materials, metal joining processes, and testing aircraft materials.

Induction Heating Practices. *D. Warburton-Brown. Philosophical Library, Inc., New York 16, N. Y. 1956. Cloth, 6 by 9 in., 192 pp. Price $10.*

An up-to-date study by a leading British expert on the application of the high frequency induction heating process to brazing, soldering, hardening, annealing, tempering and other heating requirements in engineering.

The book gives valuable information on the design of work coils and inductors, and on modifying the design of components and assemblies to facilitate use of the process.

The remainder of the book deals with various applications, first giving general notes on each application and then going on to specific examples, such as motor and motor accessories, typewriters, gold melting, electrical components and precision instruments. A complete chapter is devoted to the special problems of gear hardening.

(Reports on p 202)

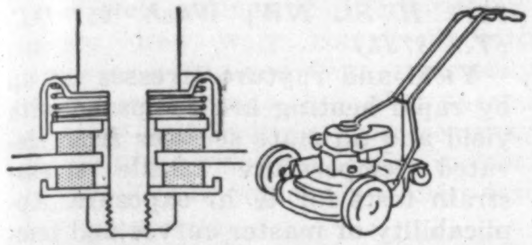
TAYLOR
Laminated Plastics
Vulcanized Fibre

Shop Talk

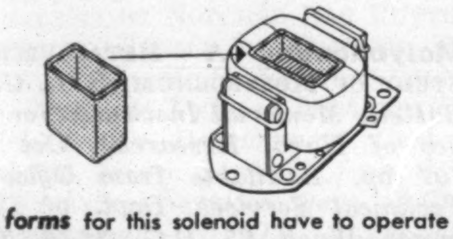
TAYLOR FIBRE CO.
Plants in Norristown, Pa. and La Verne, Calif.

PHENOL—MELAMINE—SILICONE—EPOXY LAMINATES • COMBINATION LAMINATES • COPPER-CLAD LAMINATES • VULCANIZED FIBRE

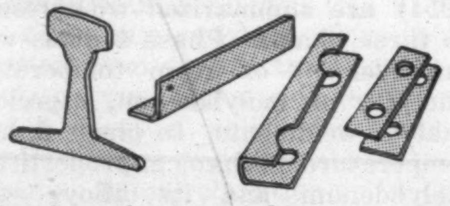
Tips for designers



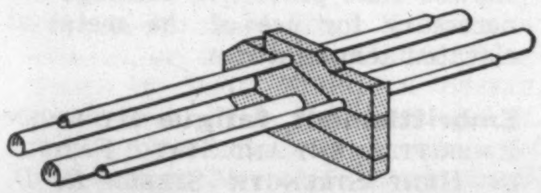
Rotary lawn mower **utilizes abrasion resistance of Taylor phenol laminate washer in slip-clutch attachment of drive shaft to cutting blade.**



Coil forms **for this solenoid have to operate at high temperatures . . . an ideal application for Taylor glass melamine laminates.**



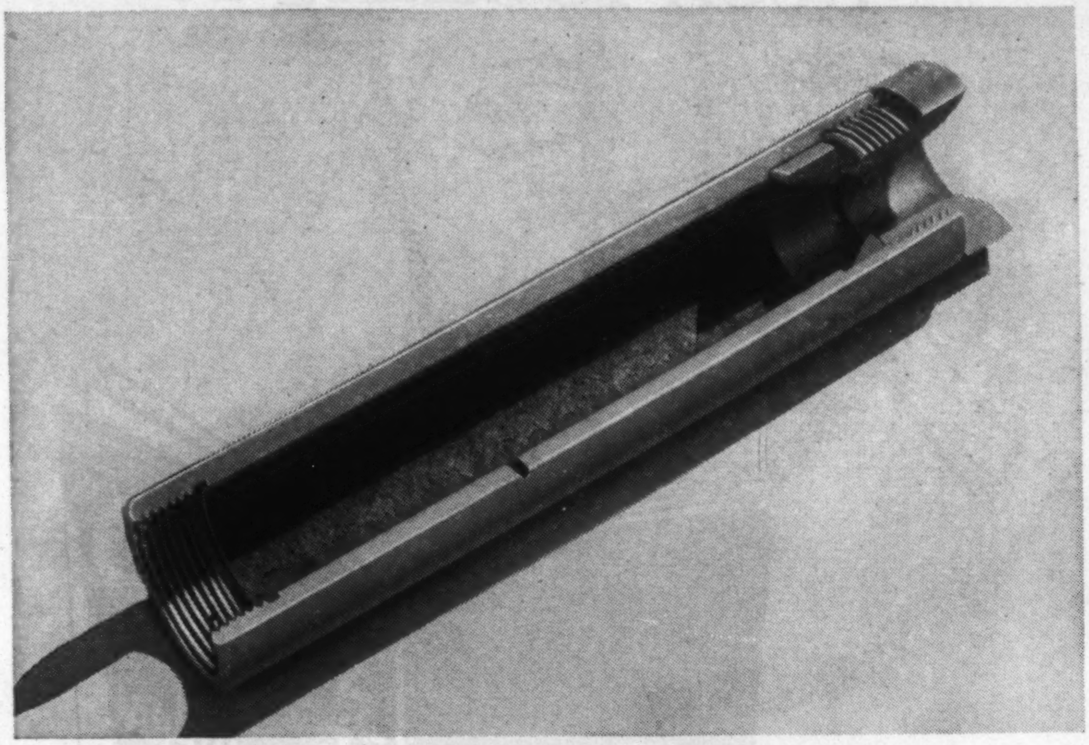
Railroad track-joint insulation, **a specially developed grade of Taylor vulcanized fibre, withstands heavy impact and mechanical stress of high-speed trains.**



Fuel-line clamp **for a fighter plane's "pipeline" system is machined from Taylor fabric base laminate which has high mechanical strength and resists extreme temperature and humidity.**

NEW TAYLOR
COPPER-CLAD LAMINATES

Taylor GEC (glass-epoxy) Copper-Clad and Taylor XXXP-242 cold punching (paper-phenol) Copper-Clad. Taylor uses high purity rolled copper on base materials with outstanding electrical properties.



Fuse holder used in power lines for underground trolley service is machined to extremely close tolerances from Taylor Grade XX tubing.

Make strong insulated parts

. . . from TAYLOR *laminated tubes and rods*

These rugged, readily machined materials make outstanding electrical or mechanical components—at substantial savings in fabrication, assembly, and material costs. Taylor Laminated tubes and rods are the logical choice wherever specifications call for mechanical strength, heat resistance, and electrical insulation.

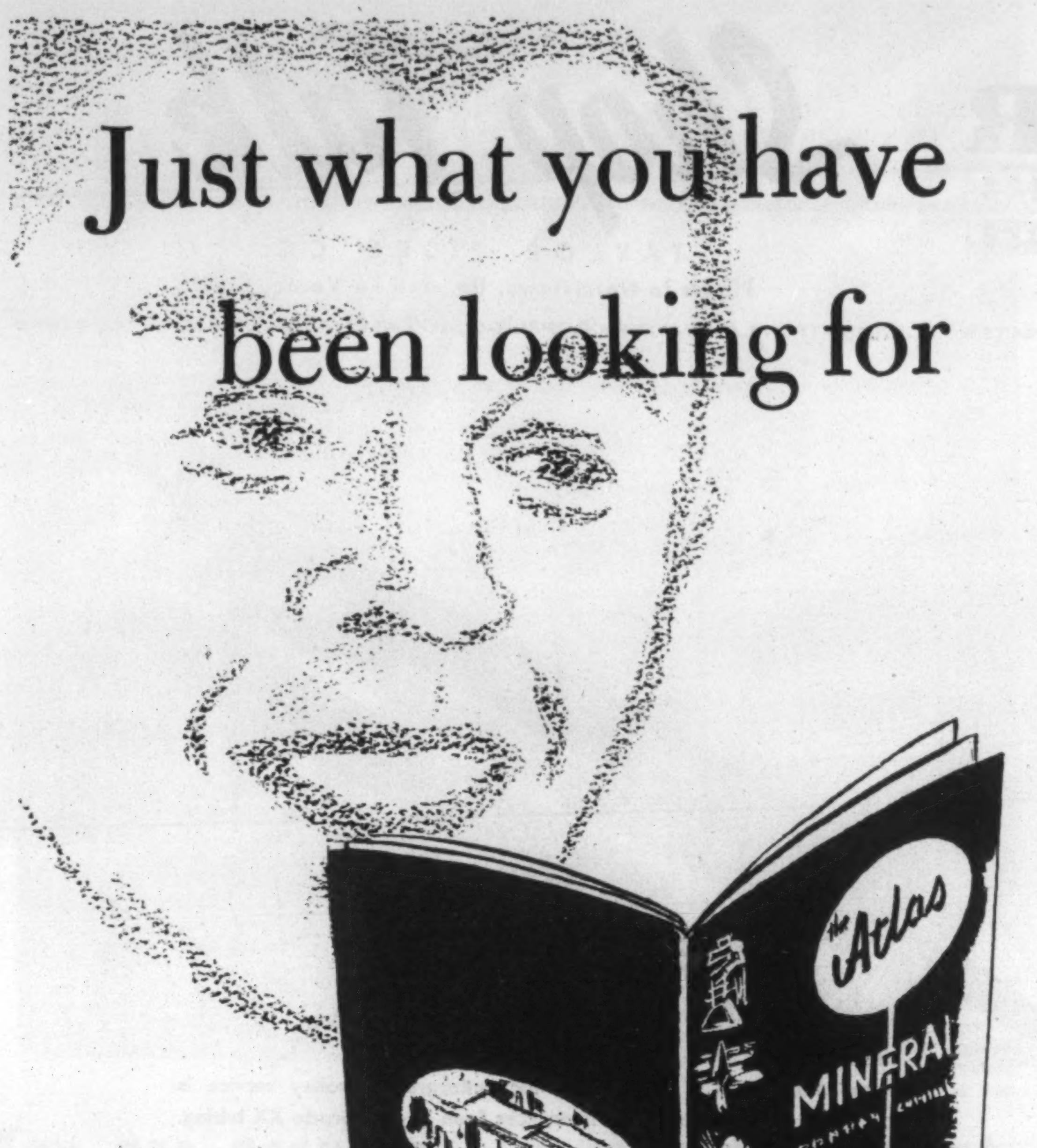
Taylor tubes and rods are made in many paper, fabric, and glass-base grades, with special formulations of phenol, silicone, melamine, or epoxy resins. Within the complete line the designer and the production man can find a variety of combinations of electrical and physical properties for a broad range of product applications.

Taylor tubes and rods are standard products. Tubes are available with inside diameters as small as three thirty-seconds of an inch . . . rods with diameters from one-sixteenth of an inch.

A Taylor sales engineer will be glad to help you select the grade and size of laminated tubes cr rods to match the exact requirements of your application. And, you can eliminate many purchasing, stocking and manufacturing problems by having the Taylor Fabrication Division produce finished parts to your specifications. Call your nearest Taylor sales engineer for a discussion of your specific needs.

For more information, turn to Reader Service Card, Circle No. 417

Just what you have been looking for



THE ANSWER TO **your corrosion problems**

A completely new sixteen page bulletin on corrosion proof materials of construction. . . . Individual sections on CORROSION PROOF CEMENTS, PROTECTIVE COATINGS, TANK LININGS and RIGID PLASTIC STRUCTURES and PIPE . . . also sections including engineering design and corrosion resistance charts.
This bulletin is filled with valuable information on 18 materials that can be used to give you plant-wide protection from corrosion.

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ATLAS MINERAL PRODUCTS COMPANY
MERTZTOWN, PENNSYLVANIA

TECHNICAL REPRESENTATIVES THROUGHOUT THE UNITED STATES

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CONTENTS NOTED

REPORTS

Inconel and titanium TENSILE PROPERTIES OF INCONEL AND RS-120 TITANIUM-ALLOY SHEET UNDER RAPID-HEATING AND CONSTANT TEMPERATURE CONDITIONS. *G. J. Heimerl, I. M. Kurg and J. E. Inge. July '56. 29 pp, illus. Available from National Advisory Committee for Aeronautics, 1512 H St. NW, Wash. 25, D.C. (TN 3731)*

Yield and rupture stresses set up by rapid heating are compared with yield and ultimate stresses from elevated temperature tensile stress-strain tests for ½ hr exposure. Applicability of master curves and temperature rate parameters to prediction of yield and rupture stresses and temperatures under rapid heating conditions was investigated.

Molybdenum A METALLURGICAL STUDY OF MOLYBDENUM. *S. L. Case, Battelle Memorial Institute (for Office of Naval Research), Oct '54, 107 pp. Available from Office of Technical Services, Dept. of Commerce, Wash. 25, D.C. $2.75. (PB 111753)*

Results of a 5 yr study (1949 to 1954) are summarized with respect to three phases. Phase 1 deals with improvement of room temperature ductility of molybdenum, especially that of weldments. In phase 2, high temperature mechanical properties of molybdenum and its alloys were measured. A binary molybdenum alloy containing about 2.5% titanium showed considerable promise for high strength use. Phase 3 of the project showed that protective coatings are necessary for use of the metal at elevated temperatures.

Embrittlement, fatigue HYDROGEN EMBRITTLEMENT AND STATIC FATIGUE IN HIGH STRENGTH STEEL. *R. D. Johnson, H. H. Johnson, W. J. Barnett and A. R. Troiano, Case Univ. of Technology (for Wright Air Development Center), Aug. '55, 41 pp. Available from Office of Technical Services, Dept. of Commerce, Wash. 25, D.C. $1.25. (PB 121064)*

The temperature dependence of delayed failure time indicated that crack propagation was controlled primarily by the inward diffusion of hydrogen. Initial embrittlement introduced by cadmium plating—commercial or laboratory—equaled that introduced by standard hydrogen charging conditions. The plating showed great influence in delaying recovery.

Properties of castings EFFECT OF GEOMETRY ON THE PROPERTIES OF 195-T6 AND 356-T6 ALUMINUM AL-

For more information, Circle No. 570 »

LOY CASTINGS. *W. H. Johnson and H. F. Bishop, Naval Research Laboratory, June '56, 16 pp. Available from Office of Technical Services, Dept. of Commerce, Wash. 25, D.C. 50¢. (PB 121227)*

Tensile properties were determined at various locations in aluminum alloy castings of different thicknesses, and were compared with properties obtained from separately cast bars. Results show that special molding and melting processes may be used to develop properties in castings which approach or exceed test bar properties.

Notch sensitivity NOTCH SENSITIVITY OF HEAT RESISTANT ALLOYS AT ELEVATED TEMPERATURES, PART 2: ANALYSIS OF NOTCHED BAR RUPTURE LIFE IN TERMS OF SMOOTH BAR PROPERTIES. *H. R. Voorhees and J. W. Freeman, Univ. of Michigan (for Wright Air Development Center). Jan '56, 86 pp. Available from Office of Technical Services, Dept. of Commerce, Wash. 25, D.C. $2.25. (PB 121184)*

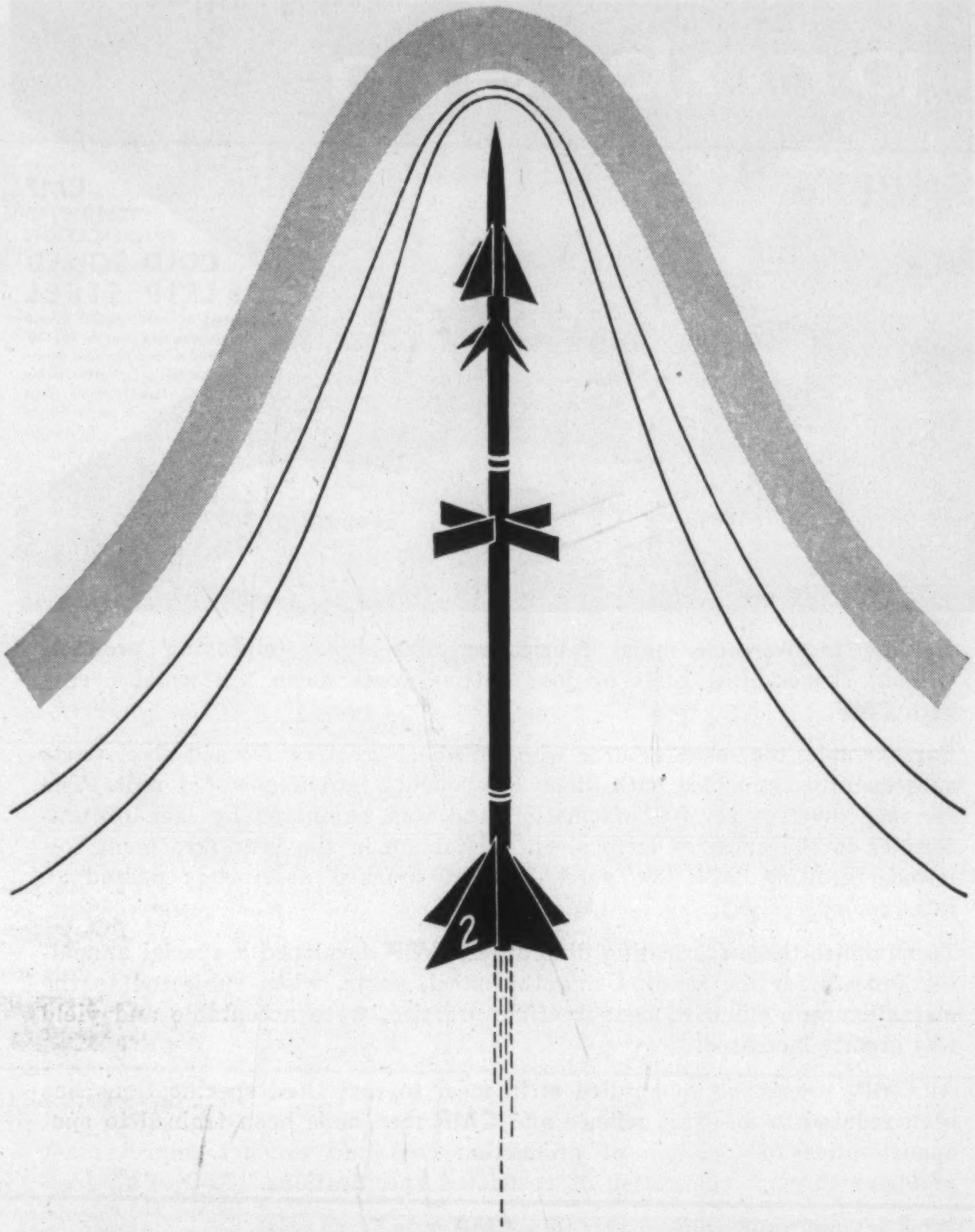
Rupture lives of smooth and notched bars were compared in tests on three heat resistant alloys having conventional heat treatments. A definite qualitative agreement was noted between notch strengthening or weakening and the rate of experimental stress relaxation under creep conditions. A quantitative stepwise analysis was developed to compare notch rupture behavior with properties of smooth bars.

Silicon in steel SOME EFFECTS OF SILICON OF THE MECHANICAL PROPERTIES OF HIGH STRENGTH STEELS. *C. H. Shih, B. L. Averbach and M. Cohen, Massachusetts Institute of Technology. Nov 1955. 59 pp. Available from Office of Technical Services, Dept. of Commerce, Wash. 25, D.C. $1.50 (PB 121225)*

Higher tensile strength is attained with no decrease in ductility by increasing silicon content to 1.5% in AISI 4340 and 4325.

Testing silicone rubber TESTING OF SILICONE RUBBER AT ELEVATED TEMPERATURES. *Aldo J. deFrancesco, Connecticut Hard Rubber Co. Jan 1956. 41 pp, photos, diags, graphs, tables. Available from Office of Technical Services, Dept. of Commerce, Wash 25, D.C. $1.25 (PB 121192)*

Describes an apparatus to measure tensile strength, elongation and tear strength of silicone rubber at elevated temperatures. Fifteen different silicone compounds were tested at room temperature, 212 and 400 F.



now magnesium castings for high temperature applications

Now you can enjoy the high strength-weight ratio of magnesium at high temperatures. Alloys now being cast by Rolle have the tensile strength and creep resistance modern jets and missiles demand . . . even at temperatures above 600F.

Developed by Magnesium Elektron Ltd., these rare-earth magnesium alloys were pioneered in this country by Rolle personnel. And in the hands of Rolle foundry engineers, the published specifications of the alloys are being realized to the utmost in casting after casting.

As a specialist in the sand, permanent mold, shell, and investment casting of the light metals, Rolle can offer you unrivalled experience from design through pouring and testing . . . whether you need creep resistance above 600F or not. Take advantage of that experience by bringing your casting problems to Rolle. You'll be assured of the best possible casting in the one alloy that meets all your needs, and at the same time, you'll save time, trouble, *and* expense.

FREE 57-PAGE ENGINEERING MANUAL *helps you design and specify aluminum and magnesium castings. Available on letterhead request. Write for your personal copy.*

for complete foundry service **ROLLE**

MANUFACTURING COMPANY

303 Cannon Avenue, Lansdale, Pa. Lansdale 5162

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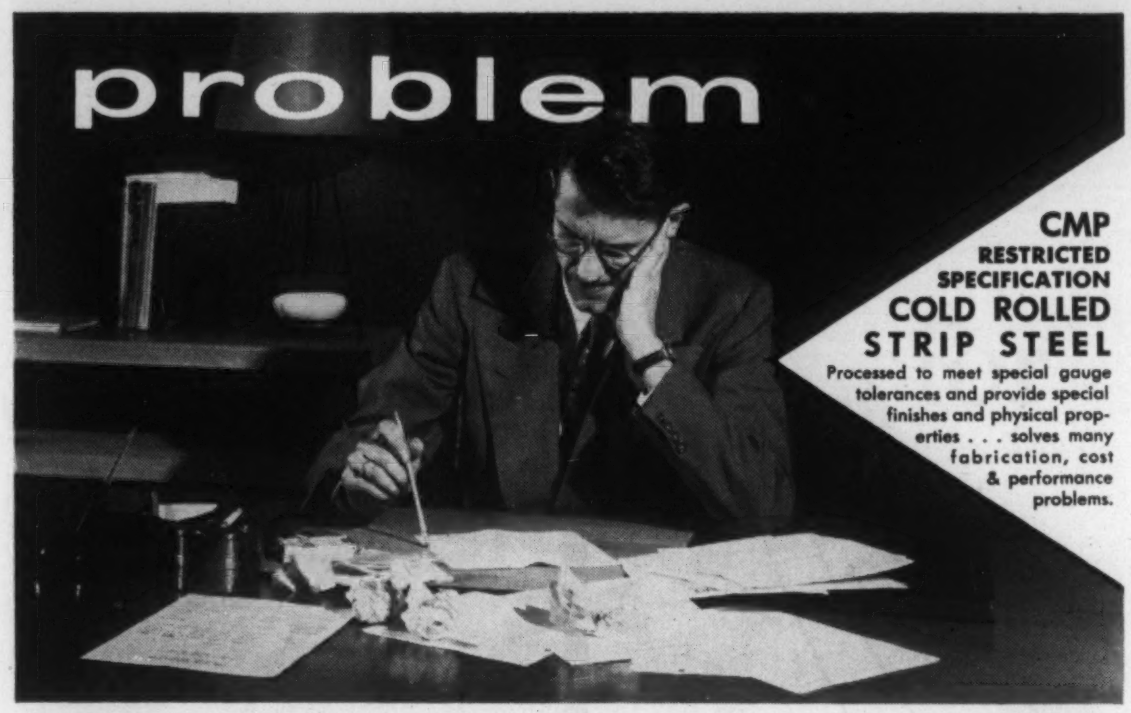
problem
CMP
RESTRICTED
SPECIFICATION
COLD ROLLED
STRIP STEEL
Processed to meet special gauge tolerances and provide special finishes and physical properties . . . solves many fabrication, cost & performance problems.

Helping to overcome metal fabricating difficulties, improving products without skyrocketing costs or just getting costs down are usual events with **CMP.**

For example, the manufacturer who was heat-treating formed steel parts subsequently assembled with other components into a powered unit. The forming involves severe deformation and was hampered by lack of uniformity in the annealed strip steel. Distortion in the heat treatment followed, resulting in a low percentage of finished assemblies passed as satisfactory.

To minimize these fabricating difficulties, **CMP** developed a special annealing process for the strip. Using this steel, parts, when subjected to the manufacturer's standard heat-treating practice, were acceptable and yield was greatly increased.

At **CMP,** processing cold rolled strip steel to restricted specifications has been reduced to an exact science and **CMP** men have been trained to spot opportunities for solution of production cost and product improvement problems through application of restricted specifications.

Why not put your problems up to a **CMP** man?

C M P

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PLANTS: YOUNGSTOWN, OHIO AND INDIANAPOLIS, IND.
SALES OFFICES: NEW YORK CLEVELAND DETROIT INDIANAPOLIS
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CMP
RESTRICTED
SPECIFICATION
COLD ROLLED
STRIP STEEL
is available in
Low Carbon Grades • High Carbon Spring Steel (annealed and tempered) • Stainless Types • Alloy Grades • Electro Zinc Coated
solved

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NEWS OF ENGINEERS COMPANIES SOCIETIES

Richard R. Kesti is the recently appointed chief engineer of both Valvair Corp. and Sinclair-Collins Valve Co.

Dr. Gerhard Reethof has been made chief of research and **LeRoy D. Taylor,** assistant chief engineer for development, Vickers Incorporated.

Dr. Harold J. Dawe is now technical staff consultant of Acheson Industries, Inc.

Donald R. Church has been named chief engineer, Acoustica Associates, Inc.

Theodore W. Bossert has been advanced to chief metallurgist, Aluminum Co. of America. Mr. Bossert had been serving as assistant chief metallurgist of the metal manufacturing divisions.

Chedo P. Graham has been promoted to chief engineer, Aro Equipment Corp.

Hyman Rosenthal is the new director of research of Arwood Precision Casting Corp.

Albert S. Burgoyne has the newly created office of vice president in charge of manufacturing, E. W. Bliss Co.

Dr. Robert F. Mehl, director of Metals Research Laboratory and head of metallurgical engineering at Carnegie Institute of Technology, has been awarded the "Grand" Medal of Le Chatalier by the Council of the French Society of Metallurgy for distinguished service in the field of metallurgical engineering research.

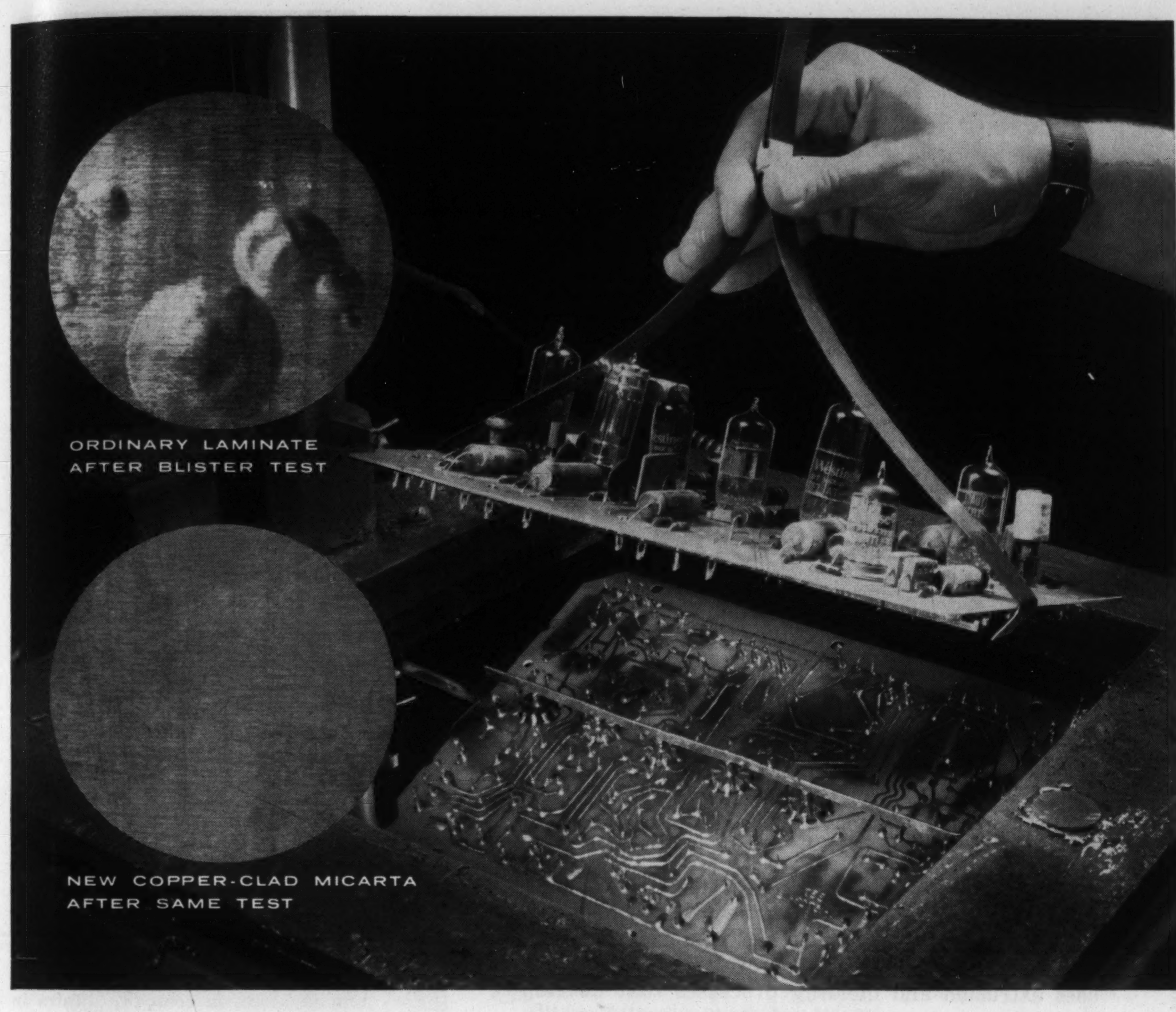
Albert J. Hanssen has joined Conoflow Corp. as chief engineer.

R. Karl Smith is manager of product engineering in the Refractories Div., Corning Glass Works.

Thomas A. Carr has been made supervisor of metallurgy and quality control, Spring Div., Crucible Steel Co. of America.

Dr. Griffin D. Jones is now director of Dow Chemical Co.'s Physical Research Laboratory.

Robert D. Flori has been elected president of the new combination of Flori Pipe Co. of St. Louis and



New copper-clad MICARTA® takes dip solder bath without blistering!

New H-3032 copper-clad MICARTA® cuts costs and production time of printed circuits. Copper-clad MICARTA speeds up soldering, without the normal accompaniment of an increase in rejects and missed connections. It can be cold punched without cracking or chipping.

The laminate won't blister even when dip soldered for 10 seconds at 500°F! Examine the two close-up photographs. One shows an ordinary laminate after a laboratory test. Note the blistering, then look at the MICARTA dip soldered for the same length of time—and there is no blistering!

A special adhesive is used which has the same high electrical properties, solvent resistance and low moisture absorption as the MICARTA laminate itself. Actually, adhesive strength is increased during soldering.

Because of a new adhesive process, copper-clad MICARTA keeps its high bond strength—from 10 to 13 pounds versus an industry standard of six pounds—even after heating and cooling is repeated many times. This is especially valuable for electronic circuits.

Copper-clad MICARTA may be the answer to your circuit assembly problem. Write for further information and technical data to Westinghouse Electric Corp., MICARTA Div., Hampton, S. C.

J-06624-X

WATCH WESTINGHOUSE!

*WHERE **BIG** THINGS ARE HAPPENING FOR **YOU!***

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Note:

Specify properties when you use TEFLON®

EXPERIENCE shows that in converting Teflon powders into shapes the combination of method and raw material used have a definite effect on physical and electrical properties.

Since properties *can* vary, it becomes important to *specify* those needed.

End products made from Fluoroflex®-T (Teflon) rods, sheets and tubes will have the specified, required properties . . . will thus perform properly. For, in producing two grades of Teflon, Resistoflex uses extrusion and molding processes that develop the optimum properties in each . . . with quality carefully controlled for *consistent* performance.

"Electrical grade" Fluoroflex-T rods, sheets and tubing are certified to conform with AMS 3651 on all important electrical and physical properties. They're recommended for the most critical uses.

"Mechanical grade" extruded rods and tubing, having improved resistance to elongation, prove ideal for bearings, valve seats, nozzles and other mechanical parts.

All Fluoroflex-T products are stress relieved for dimensional stability in machined parts. Send for data.

® Teflon: DuPont trademark *® Fluoroflex: Resistoflex trademark*

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the Houston Pipe & Steel Co.

Dr. Paul J. Flory has been chosen as executive director of research, to head Mellon Institute's investigational activities.

E. W. McGovern has been appointed assistant technical director—carbide operations at Electro Metallurgical Co.'s Niagara works.

Clifford W. Brown, formerly vice president and general manager of Narmco Resins and Coatings Co., has been advanced to president of the firm.

Thomas G. Digges has been made assistant chief of the Metallurgy Div., National Bureau of Standards.

Theodore J. Englund is manager of industrial engineering; **Paul L. Lantz,** assistant manager of industrial engineering; **William F. Watts,** factory manager of the Refractories Div.; and **William P. Densmore,** chief industrial engineer, Norton Co.

Edward T. Bryand has joined the staff of Portland Copper and Tank Works, Inc., as supervisor, New Products Dept.

Alexander H. d'Arcambal has retired as president and general manager of Pratt & Whitney Co., Inc. He will remain active in company affairs in a consulting capacity and as honorary chairman of its board of directors.

J. J. Punke has been elevated to executive vice president, Precision Castings Div., Harsco Corp.

O. Jay Myers is now associated with Reichhold Chemicals, Inc., as vice president in charge of the Foundry Div.

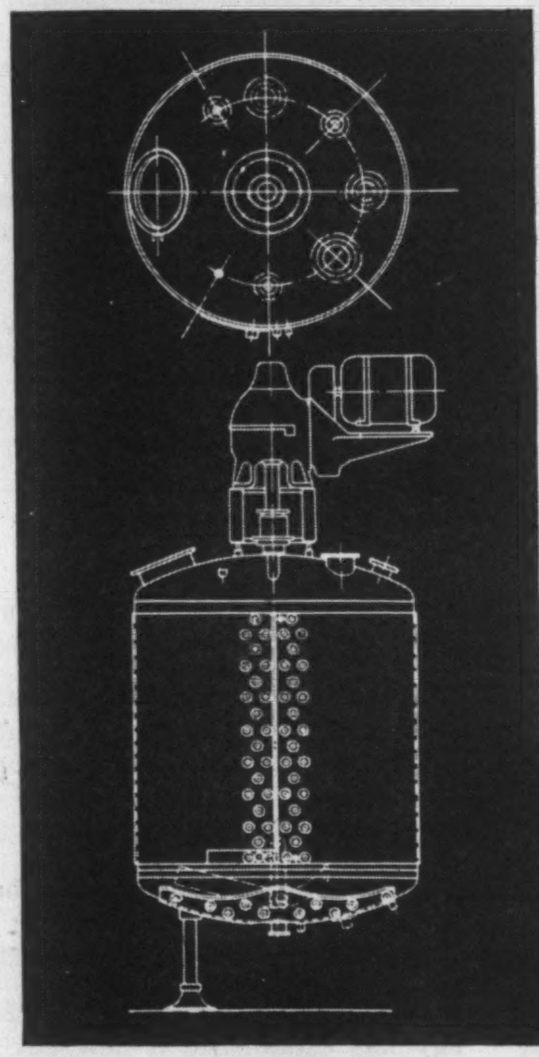
Matthew J. Donachie, former president, chief metallurgist and director of Beryllium Corp., has been appointed works manager, Prentiss Wire Mills, Riverside Metal Div., H. K. Porter Co., Inc.

Donald C. Erdman, formerly president of Electro Circuits, Inc., is assistant to the president, Sperry Products, Inc.

Stefan J. Garvin has become associated with Thomas & Skinner, Inc., as manager of operations in charge of all manufacturing, engineering and research activities.

(News of Companies on p 210)

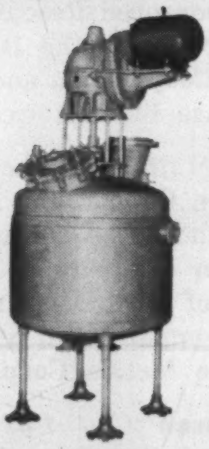
can you afford not to use TITANIUM?



By themselves, catalog prices of raw materials can be misleading. For it's the final cost—in terms of service life—that really determines what you pay for equipment.

The following table, based on cost analysis by the Pfaudler Company, indicates their estimate of comparative costs of producing the reactor unit shown at the left, using titanium, and two other well-known, corrosion-resistant metals.

	REM-CRU A-55 TITANIUM	METAL A	METAL B
Cost per lb.	$14.60	$0.8025	$2.62
But titanium's light-weight means less is needed . . .			
Material Required	250 lbs.	785 lbs.	675 lbs.
So the comparative cost factor is reduced . . .			
Material Costs	$3650.00	$630.00	$1768.00
Fabrication takes the lions' share, so . . .			
Cost of Finished Reactor	$12,150.00	$2391.00	$4670.00
And in corrosive chlorides, hot acids, and many other environments, laboratory and service data show . . .			
Service Life	5 years	6 months	1 year
NOW . . .			
COST Per Service Year	**$2430.00**	**$4782.00**	**$4670.00**



Reactor unit of REM-CRU titanium built by the Pfaudler Co., Rochester, N. Y. and Elyria, Ohio a skilled fabricator of titanium and other corrosion-resisting materials.

Don't be fooled by raw material costs alone—*it's the cost per service year that really counts.* Then, too, down-time losses while equipment is being replaced can quickly mount up. Another plus for longer-lasting titanium. Why not let a REM-CRU engineer help you make the best, most profitable use of titanium?

REM-CRU TITANIUM

To keep abreast of the latest developments on this vital metal, write to Dept. M-12 for the Rem-Cru Review—a free periodical presenting the latest technical data on titanium alloys.

REM-CRU TITANIUM, INC., MIDLAND, PENNSYLVANIA

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Your Engineer is Right!

Investment Casting permits new approaches to design and production engineering, unbound by the restrictions of traditional metallurgical practices and manufacturing techniques.

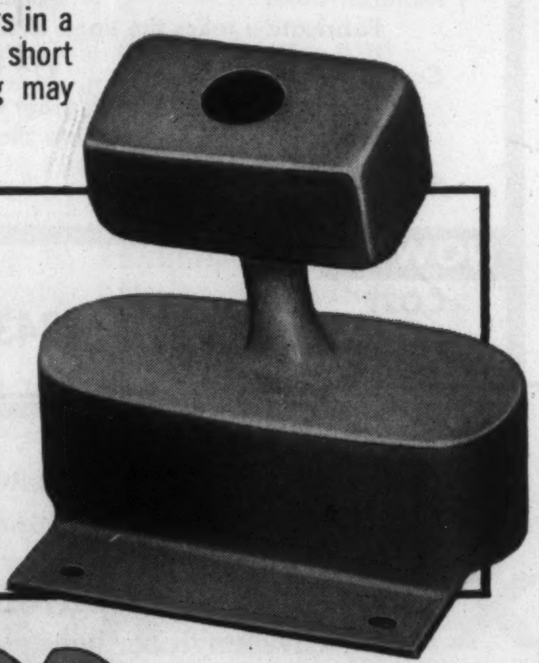
Major economies are obtained when your products or components are designed . . . or redesigned . . . with tolerance, surface and inspection criteria to conform with casting techniques. The resultant savings in final cost and production time, more than repay this small investment.

Your design engineer deserves and requires the great flexibility and latitude in design and production planning offered by Investment Casting. If application requirements demand that a part be of complex shape, intricate contours in a material that's difficult to form or machine, in short or long run quantities, Investment Casting may provide the economical answer.

CASE IN POINT!

Freedom of Design

The rudder over-balance eliminator used on the jet bomber is an investment casting of specification QQ-M-55 Magnesium, Alloy AZ-92. This intricate design is more economically produced by investment casting than any other process, permitting design freedom and assuring quality performance.



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"PIONEERS IN INVESTMENT CASTING"

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news of | COMPANIES

Shenango-Penn Mold Co., recently consolidated into the parent organization, **Shenango Furnace Co.,** will be known as Centrifugally Cast Products Div., Shenango Furnace Co.

Superior Brass Works, Inc., has purchased all the machinery, equipment and inventory of the recently liquidated **Kendrick Manufacturing Co.** Superior will continue operations of the latter company at the Kendrick plant for several months but will move operations to its own plant as soon as necessary alterations are completed.

Union Carbide and Carbon Corp. has agreed to acquire all of the business and assets of **Visking Corp.** on a basis that will provide stockholders of Visking one share of Union Carbide stock for each two and one-half shares of Visking.

Vanadium Corp. of America has transferred its Engineering Dept. to new facilities at Cambridge, Ohio.

Wabash Rubber & Plastics Corp. has opened a new 15,000-sq-ft plant in Seymour, Ind., to manufacture plastics items for the appliance and automotive industries.

Yardley Plastics Co. has purchased the Decorative Plastic Molding and Plastic Finishing Div., D. L. Auld Co.

Massachusetts Institute of Technology has established a new Division of Sponsored Research. It takes the place of both the Division of Industrial Cooperation and the Division of Defense Laboratories.

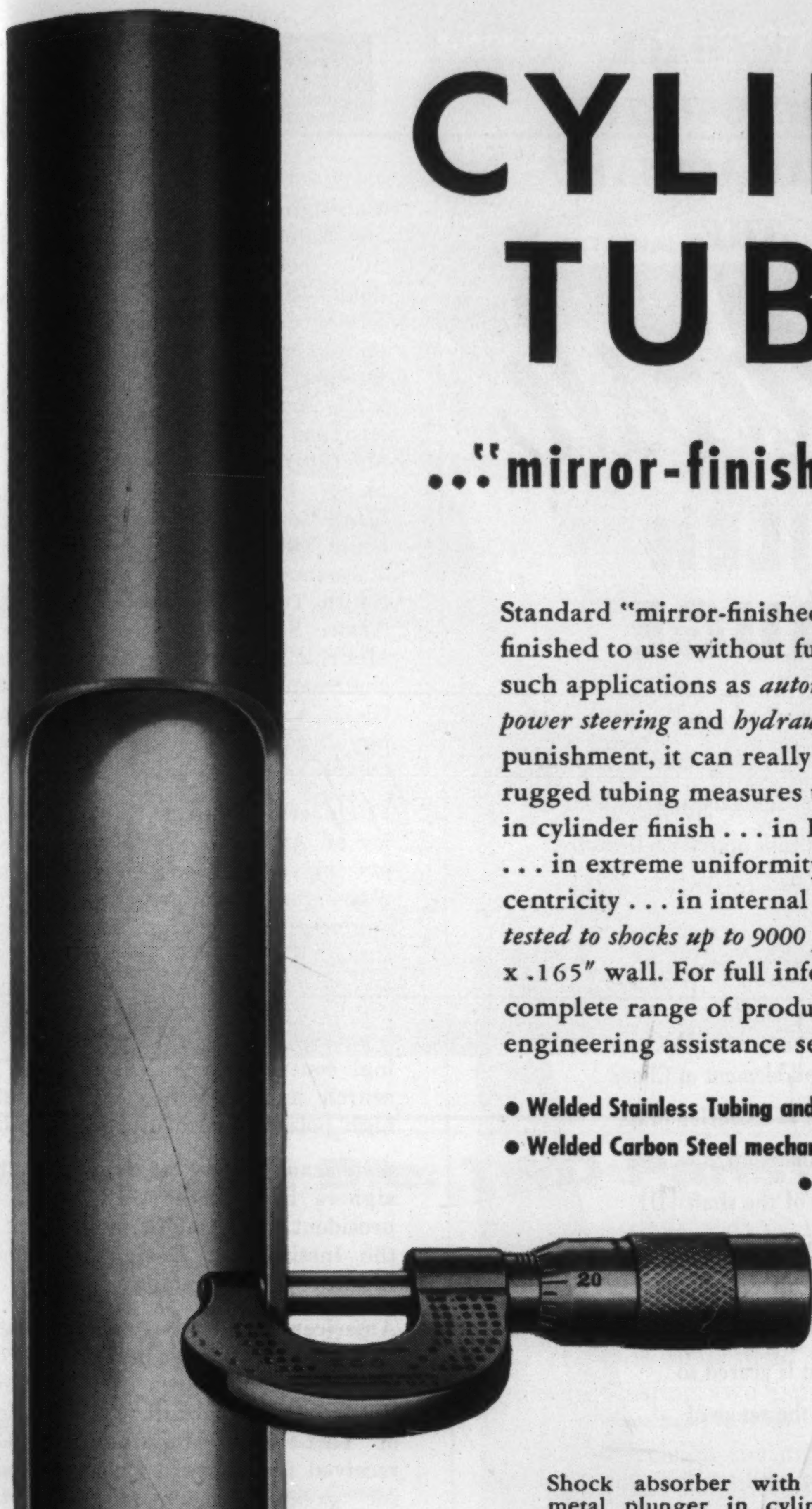
Olin Mathieson Chemical Corp. and **Revere Copper and Brass, Inc.** have announced the formation of a $231-million company to produce 180,000 tons of primary aluminum a year. The company will be known as **Olin Revere Metals Corp.**

American Can Co. has purchased **Bradley Container Corp.** American Can will maintain the company as a wholly owned subsidiary operating under the Bradley name.

American Machine & Foundry Co. has announced plans for a research and development center in Stamford, Conn., as headquarters for its Central Engineering Laboratories.

Ferro Corp. has purchased **Patterson Foundry and Machine Co.** Patterson will operate as a subsidiary of Ferro.

(News of Societies on p 212)

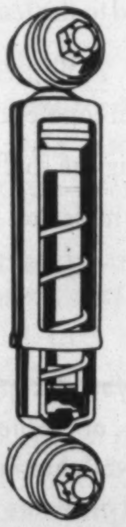


CYLINDER TUBING

...“mirror-finished” by Standard

Standard “mirror-finished” cylinder tubing is full-finished to use without further sizing or finishing for such applications as *automobile shock absorbers, power steering* and *hydraulic pumps.* When it comes to punishment, it can really take it. Every inch of this rugged tubing measures up to exacting specifications in cylinder finish . . . in ID tolerances as close as .001″ . . . in extreme uniformity of wall thickness and concentricity . . . in internal pressure resistance, *tested to shocks up to 9000 p.s.i.* Cylinder sizes to 3″ OD x .165″ wall. For full information on Standard’s complete range of products, plant facilities and engineering assistance send for *free* folder below.

- **Welded Stainless Tubing and Pipe.**
- **Welded Carbon Steel mechanical.**
- **Boiler and Heat Exchanger.**
- **Exclusive rigidized pattern.**
- **Special Shapes**



Shock absorber with metal-to-metal plunger in cylinder tube held to .001″ ID tolerance. “Mirror-finish”, concentricity and precision tolerance makes Standard cylinder-grade tubing usable *as is* for hydraulic and other cylinders.

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WELDED TUBING

Free 8-page folder on all Standard products. Write to address below.

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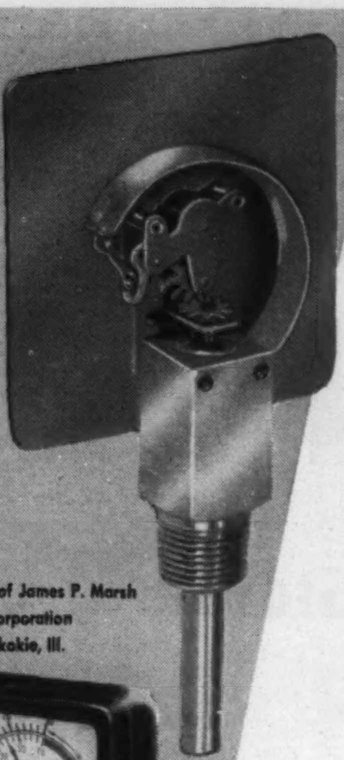
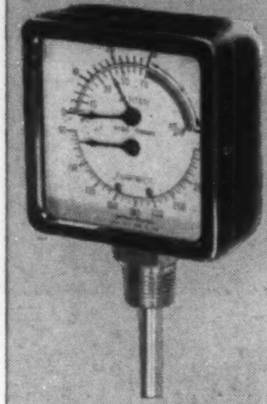
THE STANDARD TUBE COMPANY
24400 PLYMOUTH ROAD • DETROIT 39, MICHIGAN

Welded stainless tubing and pipe • Welded carbon steel mechanical • Boiler and Heat Exchanger • Exclusive rigidized patterns • Special Shapes • Steel Tubing—Sizes: ½″ OD to 5½″ OD —.028 to .260 wall • Stainless—Sizes: ¼″ OD to 4″ OD—.020 to .154 wall.

For more information, turn to Reader Service Card, Circle No. 444



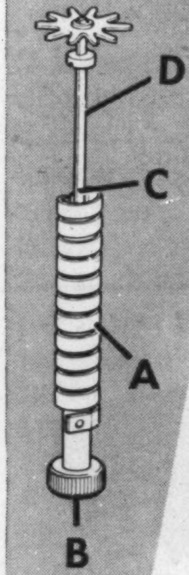
A Product of James P. Marsh Corporation
Skokie, Ill.



HOW CHACE THERMOSTATIC BIMETAL ACTUATES THE

Marsh

BOILER GAUGE



This neat Type 23 D S Q T boiler gauge is a product of James P. Marsh Corporation, manufacturers of temperature indicating devices for industry and the home. The Ther-Alti-Meter shows altitude and steam pressure and boiler temperature, all on one compact dial. The temperature gauge is actuated by an element made of dependable Chace Thermostatic Bimetal for accuracy and many years of continuous performance.

Here's how it works: The helical coil element of Chace Thermostatic Bimetal (A) is welded to a knurled brass plug (B) which is a press fit in the immersion tube. The free end (C) fits into the slotted end of the shaft (D) which is geared to the temperature indicator hand. The bending action of the bimetal in the coil causes the upper end to turn counter-clockwise as the temperature rises, thru rotating the shaft. The element is geared so that it rotates the indicator 180° between the range of 60° and 320° F.

Remember Chace when you design for temperature actuation or indication, or for protection of valuable equipment. Dependable Chace Thermostatic Bimetal is available in 28 types, in strip, coil or completely fabricated and assembled elements made to your specification. Write for new 44-page booklet, "Successful Applications of Chace Thermostatic Bimetal," containing interesting uses of bimetal and many pages of engineering data.

IT BENDS WITH THE HEAT

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Thermostatic Bimetal
1615 BEARD AVE., DETROIT 9, MICH.

For more information, turn to Reader Service Card, Circle No. 556

news of | SOCIETIES

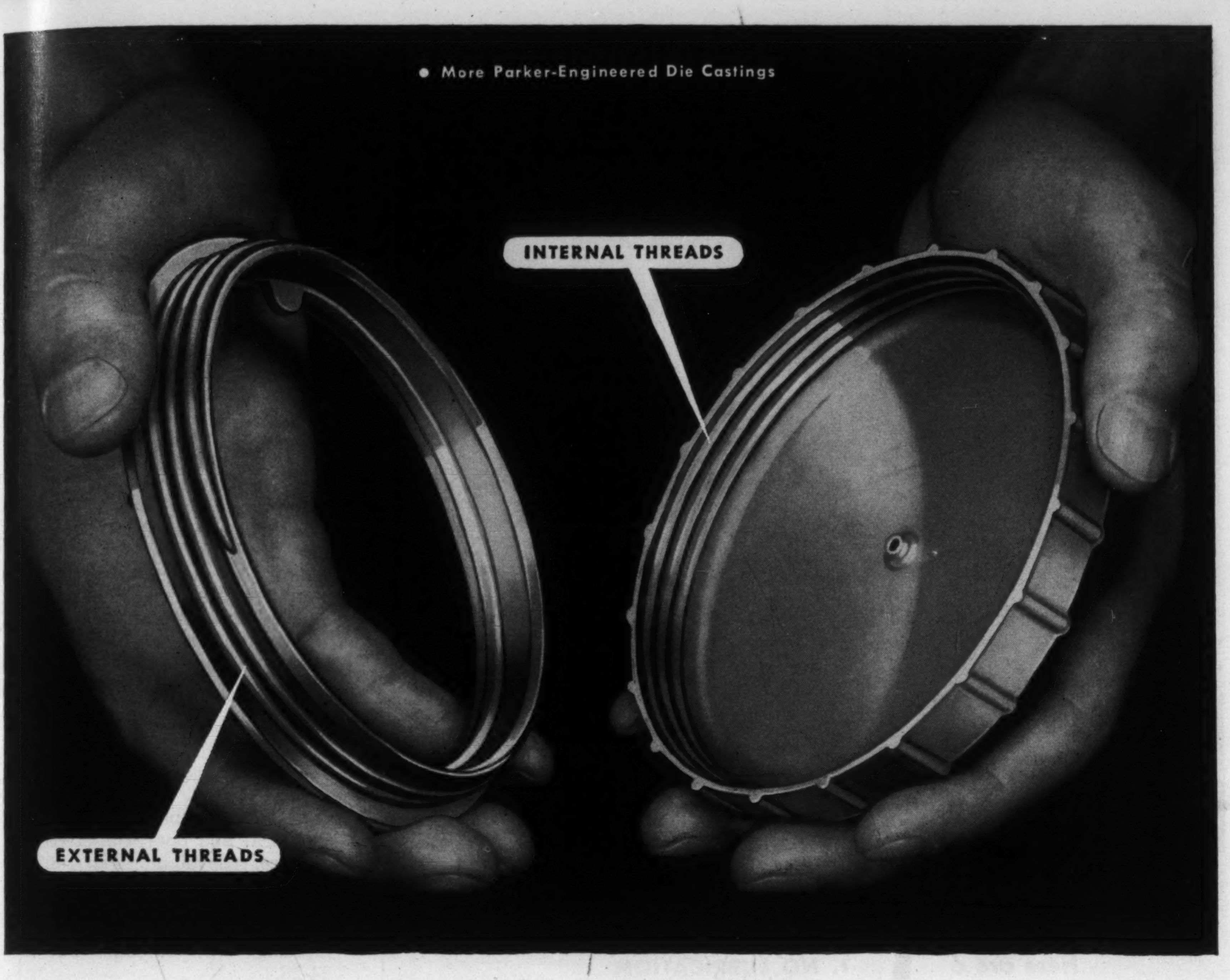
Porcelain Enamel Institute elected the following officers during its annual meeting in September: president—James W. Vicary, president, Ervite Corp.; vice presidents—A. S. Ault, Chicago Vitreous Corp.; J. J. Boehler, Heintz Mfg. Co.; J. E. Bourland, Texlite, Inc.; W. H. Lowry, Vitreous Steel Products Co.; H. F. MacIntyre, Ferro Enameling Co.; H. McE. Patton, Ingram-Richardson Mfg. Co.; H. A. Ringelberg, Challenge Stamping & Porcelain Co.; C. J. Rodman, AllianceWare, Inc.; R. N. Smith, Temco, Inc.; and J. C. Winget, Armco Steel Corp.; treasurer—P. B. McBride, Porcelain Metals Corp.; chairman of the board of trustees—Glenn A. Hutt, Ferro Corp.; managing director and secretary—John C. Oliver.

Engineering College Research Council of American Society for Engineering Education has announced plans for a major new award in engineering education. Known as the Curtis W. McGraw Research Award and sponsored by McGraw-Hill Book Co., it will be presented annually to a young man who has made an original contribution in engineering research and who has demonstrated high potential for future leadership.

American Society of Industrial Designers has elected Jay Doblin as president. Mr. Doblin is director of the Institute of Design at Illinois Institute of Technology.

American Standards Assn. presented two gold medals at its recent conference on standards in New York. Frederick S. Blackall, Jr., president of Taft-Peirce Manufacturing Co., received the Howard Coonley Medal for "great service in advancing the national economy through voluntary standards." The Standards Medal was given to Charles Rufus Harte, construction engineer of New York, New Haven and Hartford Railroad Co., for leadership in the development and application of industrial standards.

ASA has announced reelection of the following officers: president—H. Thomas Hallowell, Jr., president, Standard Pressed Steel Co.; vice president—Van H. Leichliter, vice president — operations, American Steel & Wire Div., U. S. Steel Corp.; and chairman of the Standards Council—Arthur S. Johnson, vice president, American Mutual Liability Insurance Co.



From ONE Die: TWO Parts . . . THREE Savings!

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SALES ENGINEERS

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GIRARD, Penna.
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These two mating parts, including the threads, are cast simultaneously in the same die. The result—three savings:

1—One die instead of two *saves die cost*
2—Casting two parts at one time in the same die *saves production time*
3—Precision casting of the perfectly mated threads with no parting line *saves machining cost*

Together, these three savings result in a substantially lower cost per piece. Just another example of the way Parker-engineered die castings save you money.

Parker has been a leader in die casting for over 50 years—an old hand with new ideas. This skill and experience can solve problems — and save money—on *your* component parts. Just call the nearest Parker sales engineer or write the factory direct.

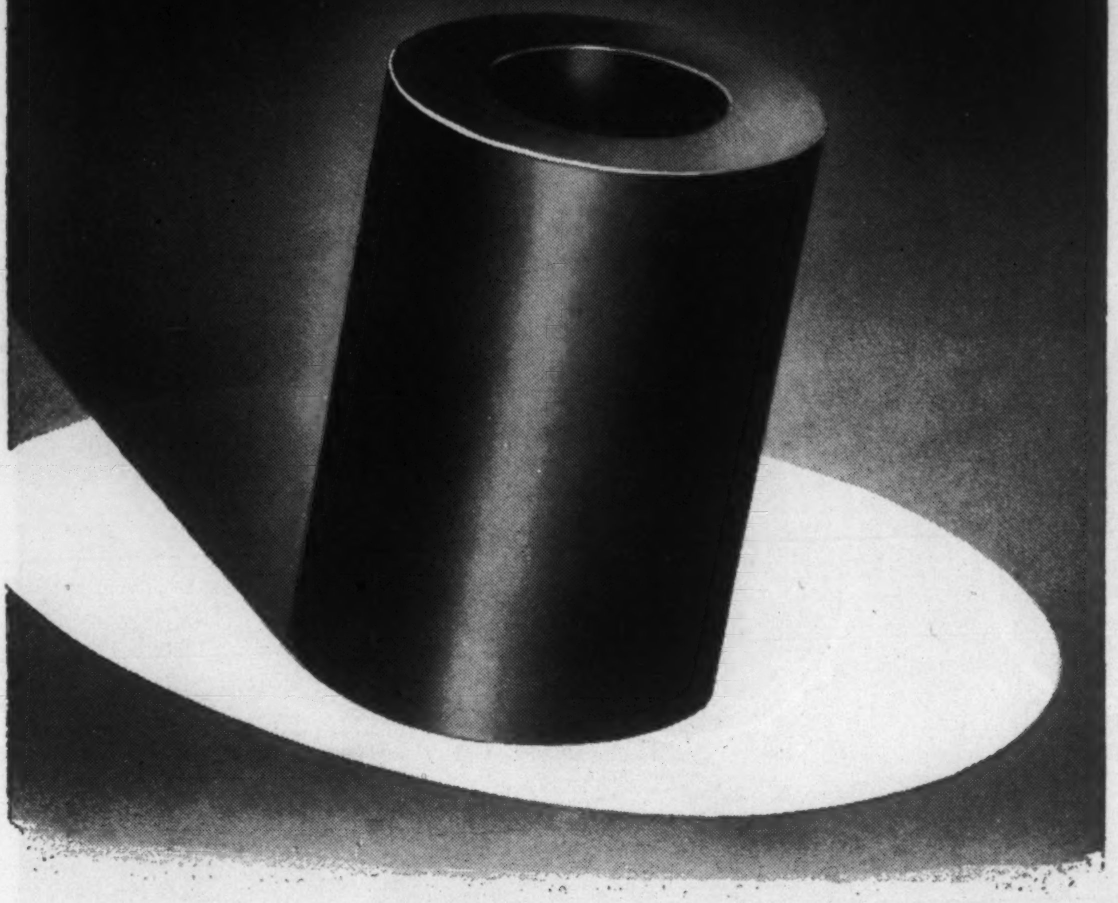
Parker White Metal Company • 2153 McKinley Ave., Erie, Pennsylvania

PARKER

high pressure
ALUMINUM and ZINC
die castings
POWDERED METAL PARTS

For more information, turn to Reader Service Card, Circle No. 523

How to get freedom from
BEARING PROBLEMS



Here are 6 operating advantages to reduce downtime, lower maintenance and increase production

1. NO LUBRICATION
2. NO MAINTENANCE
3. NO COLD-START
4. EXTENDS SHAFT LIFE
5. RESISTS HIGH TEMPERATURES
6. RESISTS ATTACK OF Corrosive Gases and Liquids

Morganite bearings are ideal for installation in inaccessible machines, and for use in hermetically-sealed mechanisms, as well as heavy industrial equipment where high temperatures and corrosion are problems. The self-lubricating qualities are inherent, producing a highly efficient bearing under almost all conditions.

Write today for latest catalog describing the many carbon and carbon-graphite products manufactured by Morganite.

50th ANNIVERSARY
TRADE MARK
1906 · 1956

Morganite
INCORPORATED

Manufacturers of fine carbon-graphite products for fifty years.
3304 48th Avenue, Long Island City 1, New York

For more information, turn to Reader Service Card, Circle No. 539

Meetings and Expositions

SOCIETY OF AUTOMOTIVE ENGINEERS, annual meeting and engineering display. Detroit. Jan 14-18.

SOCIETY OF PLASTICS ENGINEERS, annual national technical conference. St. Louis. Jan 16-18.

AMERICAN INSTITUTE OF MINING, METALLURGICAL AND PETROLEUM ENGINEERS, Engineers Joint Council. New York. Jan 17-18.

MALLEABLE FOUNDERS' SOCIETY, semiannual meeting. Cleveland. Jan 18.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, winter general meeting. New York. Jan 21-25.

AMERICAN SOCIETY FOR TESTING MATERIALS, committee week. Philadelphia. Feb 4-8.

GRAY IRON FOUNDERS' SOCIETY, committee week and spring meeting. Philadelphia. Feb 4-8.

SOCIETY OF THE PLASTICS INDUSTRY, annual Reinforced Plastics Div. conference. Chicago. Feb 5-7.

MALLEABLE FOUNDERS' SOCIETY, technical and operating conference. Cleveland. Feb 7-8.

AMERICAN INSTITUTE OF MINING, METALLURGICAL AND PETROLEUM ENGINEERS, annual meeting. New Orleans. Feb 24-28.

SOCIETY OF AUTOMOTIVE ENGINEERS, passenger car, body and materials meeting. Detroit. Mar 5-7.

PRESSED METAL INSTITUTE, annual spring technical meeting. Cleveland. Mar 6-8.

NUCLEAR CONGRESS. Philadelphia. Mar 11-15.

NATIONAL ASSN. OF CORROSION ENGINEERS, annual conference and exhibition. St. Louis. Mar 11-15.

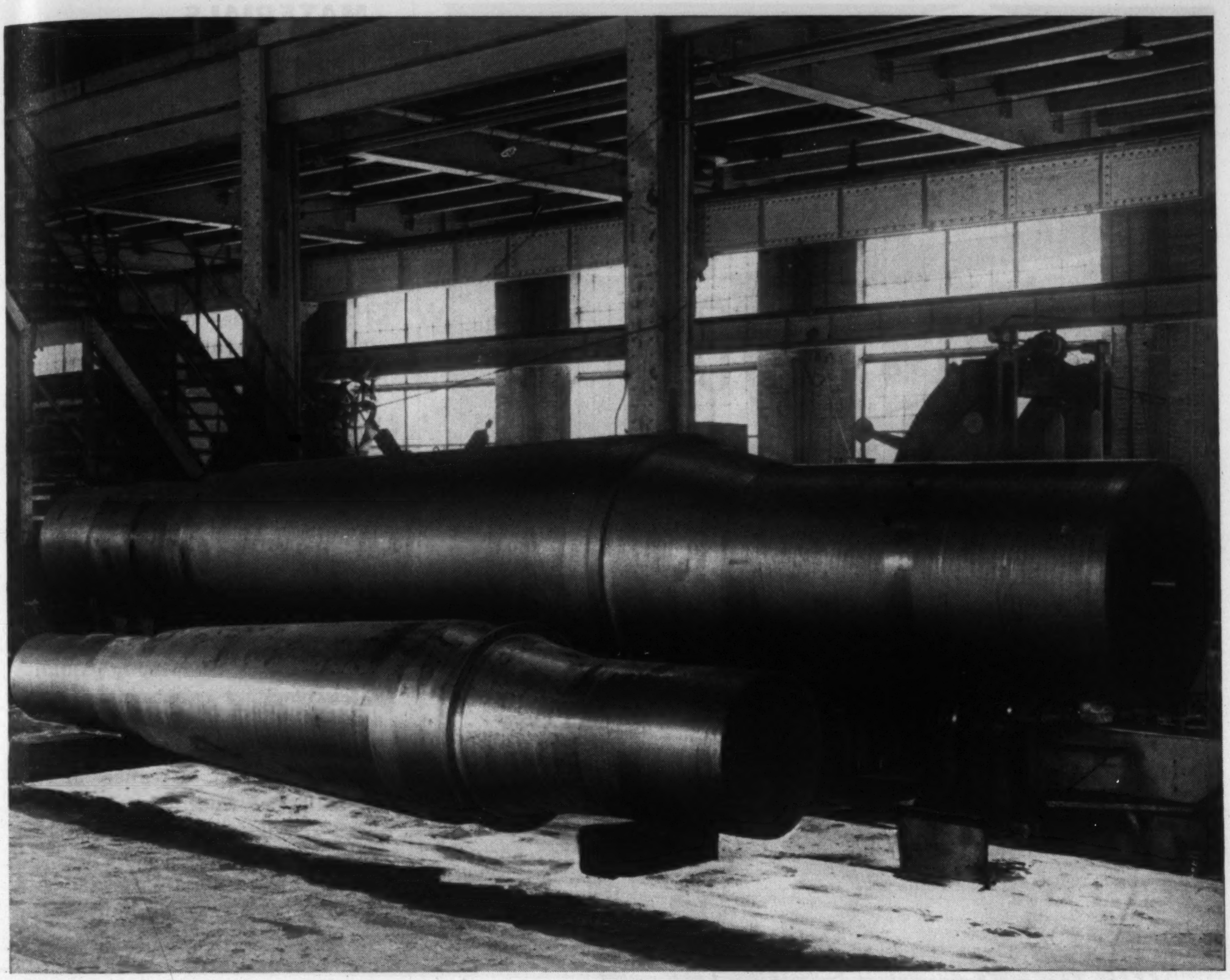
STEEL FOUNDERS' SOCIETY OF AMERICA, annual meeting. Chicago. Mar 18-19.

SOCIETY OF THE PLASTICS INDUSTRY, annual national conference and Pacific Coast plastics exposition. Los Angeles. Mar 18-21.

SOCIETY OF AUTOMOTIVE ENGINEERS, production meeting and forum. Buffalo, N. Y. Mar 20-22.

AMERICAN SOCIETY FOR METALS, Western Metals Congress and Exposition. Los Angeles. Mar 25-29.

SOCIETY OF AUTOMOTIVE ENGINEERS, aeronautic meeting and production forum and aircraft engineering display. New York. Apr 2-5.



***Forged from 3½% Nickel Steel** – These gyratory crusher shafts weigh 102,000 and 34,000 lbs. and are 25 and 17 feet long respectively. They were produced by Bethlehem Steel Company, Steelton, Pa.

*In large forgings like this...**

You get desired properties reliably with Nickel Steel

Usually husky parts like this cannot be quenched without special facilities.

How then do you get the superior mechanical properties often required in heavy-sectioned parts?

By selecting a nickel alloy steel that doesn't need a liquid quench to develop strength and toughness.

Why Nickel?

The tests of time and laws of metallurgy have proved nickel to be most valuable in developing high mechanical properties in heavy forgings. Nickel, often acting with other alloying elements, increases the hardening response of steel parts too large to liquid quench. The resulting microstructure formed gives added strength and improved toughness.

Do you have a problem?

Nickel alloy steels are used for dependable trouble-free performance in the most demanding applications. Send us the details of your problem. We may be able to help you – write today.

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WHY ENGINEERS TURN TO Tubular

...FOR *Modern* FASTENING METHODS

Today's engineers and designers using the modern "**Tubular** Way" of fastening do so for four good reasons. One is that **Tubular** rivets solve such problems as close centers and hard-to-reach locations. Another is that the full shear strength and strong clinch of **Tubular** rivets permit their use in countless jobs. A third advantage lies in lower assembly costs, because of the economy of **Tubular** rivets themselves and the speed with which they can be set. And fourth, fastening the "**Tubular** Way" means high production when you use automatic riveting machines designed by **Tubular.**

You can see how these advantages will work for you by sending **Tubular** a print, sketch or sample of your present or planned assembly. Talk to **Tubular** — for *modern* fastening methods.

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See your local classified directory for phone numbers.

For more information, turn to Reader Service Card, Circle No. 485

MATERIALS ENGINEERING NEWS

continued from p 13

dielectric materials such as quartz would have too high a loss at the high temperatures contemplated. The properties of alumina were investigated and this material showed some promise as a capacitor dielectric. Further improvement in leakage resistance could be obtained by using pure, single crystal alumina, i.e., sapphire.

An index of the relative merit of materials as high temperature dielectrics is obtained by measuring the capacitance and the electrical resistance of a disk specimen of the material at various temperatures. For a high quality mica blocking capacitor at room temperature, a value of several thousand megohm microfarads is not uncommon. Because of the difficulty of finding materials of high insulation at high temperatures, present indications are that there will be few materials with better than 1 megohm microfarad at 930F. Users of capacitors at high temperatures will have to take this limitation into account when developing circuits to include such a component.

The majority of micas crumble when heated above 1100 F, as combined water molecules are released from within the lattice structure. Work at the GE laboratory showed that certain domestic micas were not subject to such disintegration when heated, and further that the low frequency resistivity of the material was increased by such heat treatment. On the basis of such measurements, capacitors have been produced that will operate successfully at temperatures as high as 1470 F.

The limited number of materials indicated above does not represent all the available possibilities, and there is now under way active consideration of other materials. Of course, by using ceramic - titanium combinations, such as are used in the vacuum

Special Reports On Finishing Non-Ferrous Metals

NUMBER II—Paint Base, Corrosion-Resistant Finishing with Iridite

WHAT IS IRIDITE?®

Briefly, Iridite is the tradename for a specialized line of chromate conversion finishes. They are generally applied by dip, some by brush or spray, at or near room temperature, with automatic equipment or manual finishing facilities. During application, a chemical reaction occurs that produces a thin (.00002" max.) gel-like, complex chromate film of a non-porous nature on the surface of the metal. This film is an integral part of the metal itself, thus cannot flake, chip or peel. No special equipment, exhaust systems or specially trained personnel are required.

Chromate conversion coatings are well known and accepted throughout industry as an economical means of providing corrosion protection, a good paint base and decorative finishes for non-ferrous metals. However, continued developments have been so rapid and widespread that many manufacturers may not be completely aware of the breadth of application of this type of finish. Hence, this digest of current information; to bring you up to date on the many ways in which you can obtain proper surface preparation for painting and increase product durability with a single multi-purpose chemical pretreatment. Report I on decorative, corrosion-resistant finishes and Report III on chemically polished, corrosion-resistant finishes are available on request.

First, it is an accepted fact that metal surfaces should be prepared before painting to make possible an efficient paint system. Naturally, this preparation should provide for good initial paint adhesion. Chemical treatments have proved extremely effective in this respect, particularly those of a neutral or preferably acid nature. Further, to be most efficient, chemical treatments should provide a non-porous barrier to maintain adhesion by sealing the metal from the paint and moisture. They should also provide a self-healing film which prevents lateral corrosion in the event that bare metal is exposed through scratching.

The Iridite chromate conversion coatings meet all these requirements. Iridite is a chemical conversion treatment for surface preparation. It provides initial paint bonding by molecular adhesion. It is acid in nature and produces a film that is gel-like and non-porous in structure. Thus, the Iridite film effectively seals the metal from the paint and from moisture penetration. Because the film contains certain relatively soluble constituents, it will protect areas scratched through to bare metal and prevent lateral corrosion. This is accomplished by a gradual leaching of these constituents into the damaged area.

Further, because of its gel-like, non-crystalline nature, the Iridite film will not affect the appearance or texture of the paint film, nor will it dust or powder to mar the painted surface. Because the film is non-porous, paint coverage is increased, thus substantial savings in paint costs will be realized. In addition, treated parts may be stored for long periods of time prior to painting without the risk of entrapped moisture causing blistering when painting.

Iridite chromate conversion coatings are widely used with equal ease and success under both baked and air-dried paint systems. While the actual adherence properties of the Iridite film do not increase appreciably with its thickness, corrosion protection does. The protection of the Iridite film is proportionate to its thickness and should be taken into consideration when selecting the Iridite to meet your needs. However, it is sometimes necessary to sacrifice maximum corrosion protection for appearance when a finished part is to be only partially painted. For example, it may be desirable to use a thin, clear, bright Iridite film if the unpainted areas must present a chrome-like appearance. A typical case is that of instrument housings on which the exterior is painted and the inside left unpainted.

On the other hand, if all surfaces of the product are to be painted and maximum corrosion protection is required, the heavier and most protective Iridite films should be used. For example, all surfaces of zinc die cast fruit juicers are finished with a highly protective Iridite film prior to painting to provide maximum resistance to the corrosive action of fruit juices.

Iridite finishes are now available for all commercial forms of the more commonly used non-ferrous metals, including zinc, cadmium, aluminum, magnesium, silver, copper, brass and bronze. In addition to providing an excellent base for paint, the Iridite films also have high decorative value when used as final finishes in themselves.

These films can produce a wide variety of pleasing appearances including clear bright, iridescent yellow, bronze, olive drab and brown. In addition, many films can be modified by bleaching or by dyeing. Among the dye colors available are various shades of red, yellow, green, blue or black.

In planning or designing, you should consider the many other characteristics of Iridite finishes which may enter into the specific problem. In addition to their functions as protective and decorative finishes, and as bases for organic finishes and bonding compounds, Iridites have low electrical resistance. Some can be soldered and welded. The film does not affect the dimensional stability of close tolerance parts.

Iridites are widely approved under both Armed Services and industrial specifications because of performance, low cost and savings of materials and equipment.

You can see then, that with the many factors to be considered, selection of the Iridite best suited to your product requires the services of a specialist. That's why Allied maintains a staff of competent Field Engineers—to help you select the Iridite to make your installation most efficient in improving the quality of your product. You'll find your Allied Field Engineer listed under "Plating Supplies" in your classified telephone book. Or, write direct and tell us your problem. Complete literature and data, as well as sample part processing, is available. Allied Research Products, Inc., 4004-06 East Monument Street, Baltimore 5, Maryland.

(Adv.)

For more information, turn to Reader Service Card, Circle No. 404

In air-foil sections, strength, accuracy and smoothness are of primary importance. These characteristics, plus a minimum of machining, are offered by this Antioch Process missile fin casting. The alloy: A-356. Tolerances of ±.010″ in thickness and .020″ T.I.R. on flatness are held in production. Surface finish, as cast, is better than 125RMS. Test bars machined from heavy hub section have minimum ultimate strength of 36,000 psi and elongation of 11%.

Morris Bean & Company specializes in casting parts for wave guide, fluid flow, and aircraft application to demanding standards and in volume production.

If your designs call for high performance aluminum parts, get acquainted with Morris Bean castings. Send us a part print for recommendations. Technical literature on request.

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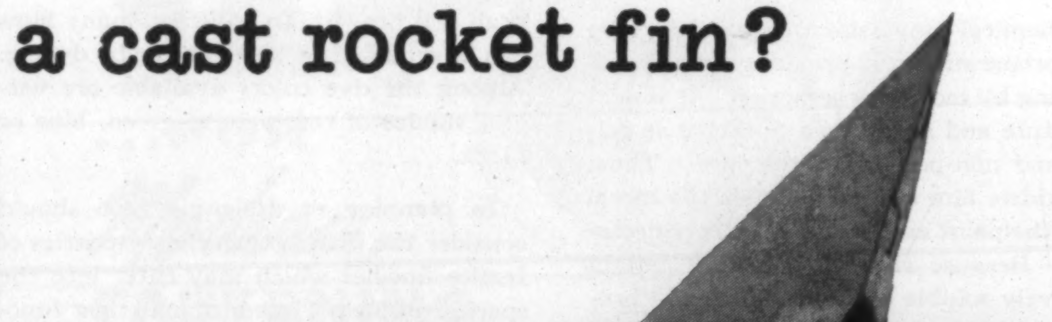
Yellow Springs 8, Ohio

a cast rocket fin?



BEAN

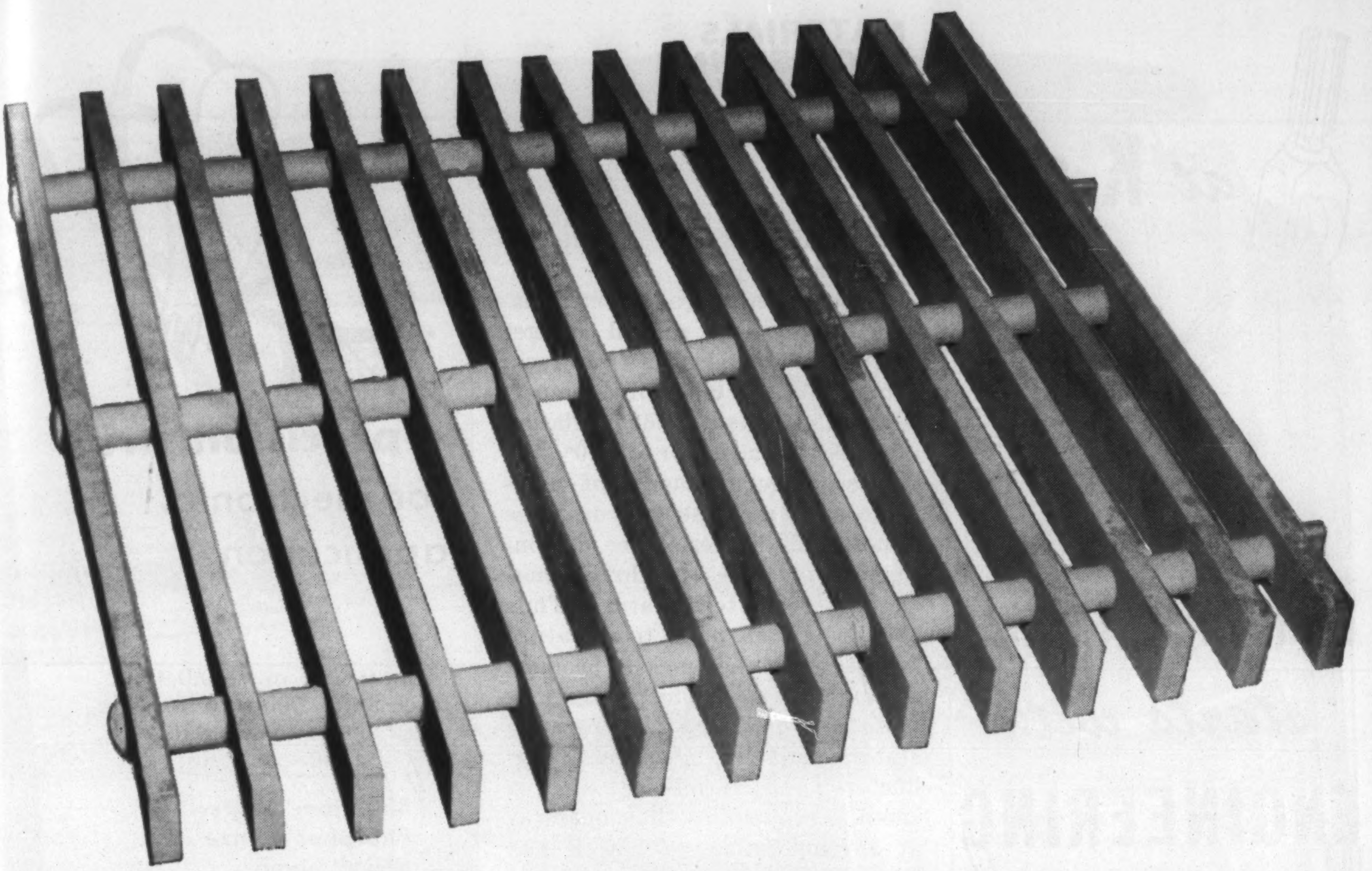
For more information, turn to Reader Service Card, Circle No. 534

tube, vacuum capacitors can be constructed having low leakage and high breakdown strength. However, because of the unity dielectric constant of vacuum, the maximum capacitance per unit volume is rather small.

Wire—Another GE development has been the progress to date on a ceramic-coated wire for use in transformers, motors, inductors and alternators. A clad copper wire is coated with a high temperature glass which provides protection from oxidation and also provides electrical insulation at working temperatures up to 930 F. At the Laboratory the wire has been used to form inductors and coils for r-f circuits, all workable to temperatures of 930 F.

Tubes—Tubes constructed from titanium metal and special ceramic parts can operate at temperatures up to 1470 F. They can be made so as to require no heater power for operation at 750 F and above. When these tubes use titanium grids and passive cathodes, they can be made to exhibit a built-in bias of up to 2 v, so that no grid battery is required. They can have exceptionally high values of transconductance.

Transformers—Tests were made with a small, two-winding transformer which operated successfully for 500 hr at a temperature of 960 F. The characteristics of common coil conductors, magnetic materials and insulations change radically at high temperatures, so that by 930 F it becomes necessary to find and develop suitable materials. For instance, common copper conductors are rendered useless by progressive oxidation; common magnetic steels lose their magnetic properties; the resistance of inorganic insulating materials drops to marginal values. In contrast, the new high temperature transformers utilize magnetic steel with a Curie temperature well above 930 F, silver- and nickel-clad cop-



STILL LIKE NEW

. . . After 100 Operations at 2300 deg. F

This tray made of Hastelloy alloy X has been heated to 2300 deg. F on more than 100 different occasions and still shows no signs of oxidation or distortion. In each cycle the tray is heated to 1300 deg. F for an hour, and then to 2300 deg. F for an additional half hour. Trays made from other materials, and used under the same conditions, failed from oxidation and warpage after a few firing cycles.

The tray is 18 in. square and is fabricated from Hastelloy alloy X sheared plate. It is used to support heavy molds during a tungsten carbide bonding process.

Hastelloy alloy X has given similar good service in other furnace applications such as muffles, flame targets, rollers, and heating tubes. It is equally suitable for use in jet engine tailpipes, afterburner components, and other aircraft parts exposed to heat and oxidation.

For complete information on properties and forms, ask for the booklet, "Hastelloy Alloy X."

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per conductors, and ceramic insulations.

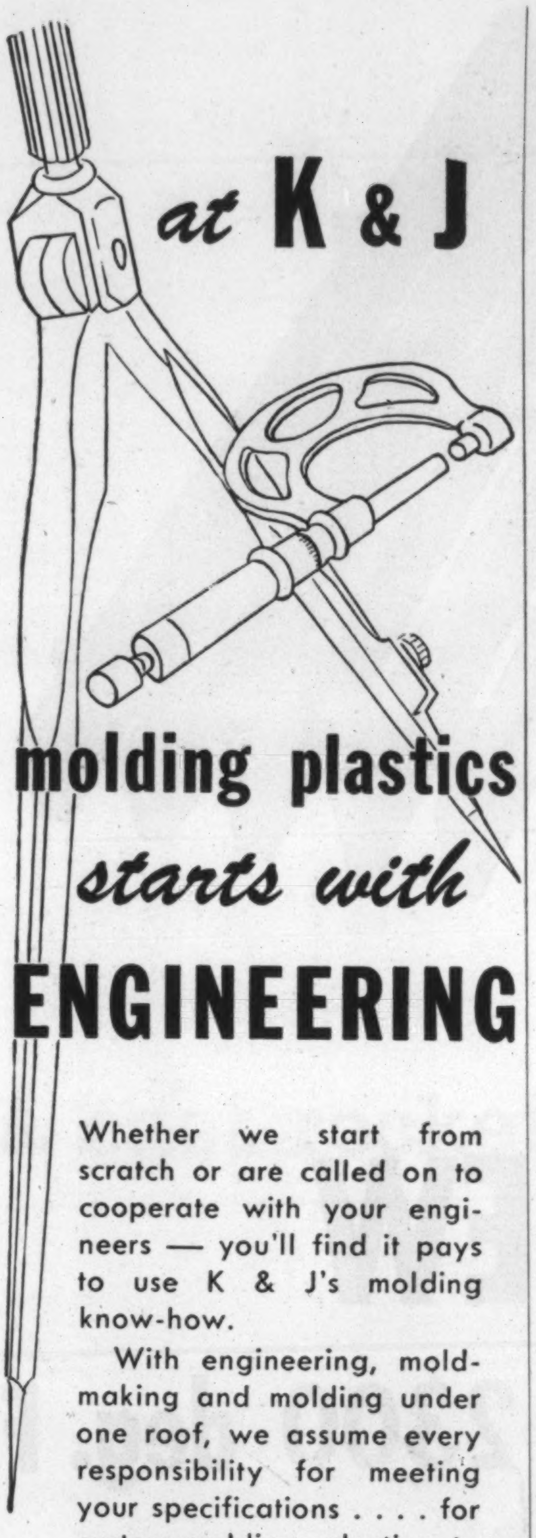
Even the new transformer materials experience radical changes in their characteristics from room temperature to operating temperature. The resistance of insulation changes by a factor of 10^6, the excitation requirements of magnetic steel increase two or three times, and the resistance of conductors increases to three times that at room temperature. Thus the design of high temperature transformers becomes a problem of material development.

Motors—Utilizing a new ceramic stator insulation, silver rotor conductors, and nickel-clad wire, a small servo motor that operates at a temperature of 930 F has been developed. It is two-phase, 400 cycle, and operates at 57 v. Stators and rotors of similar construction have been operated successfully for 1000 hr at 930 F.

Circuits—The various components to be assembled into a circuit require connections and points of support. As operating temperatures are increased, considerations of chemical stability, oxidation resistance, high electrical conductivity and mechanical strength eliminate many materials used for such circuit connections at room temperature. Up to 930 F, surface protected copper is a useful material, but for operation at 1300 F the choice is narrowed to materials such as oxidation resistant alloys and stainless steels, which have relatively high resistivity, and to the more expensive noble metals such as platinum, silver and gold.

Recent printed circuit work at the Laboratory has included use of metallic silver bonded to a ceramic base. Component mounting supports are provided by platinum wires imbedded in the ceramic at connection points. Since the platinum does not oxidize, spot welding or high temperature brazing is possible without elaborate surface cleaning.

(more News on p 222)



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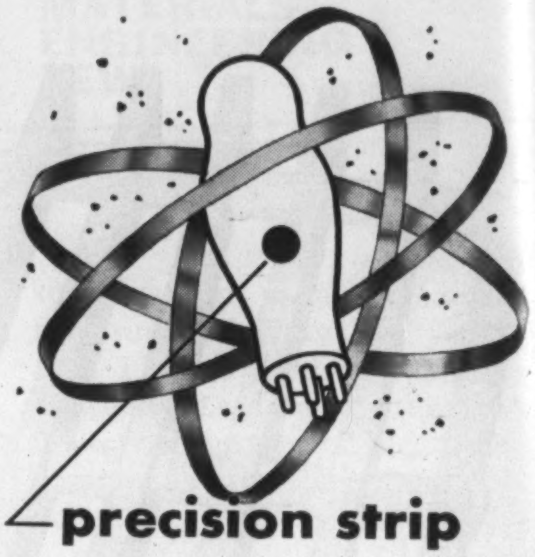

precision strip for electronics applications

From 0.0005 in. to 0.040 in. thick and 0.090 to 6 in. wide, these alloys are available as special-tolerance strip:

- Beryllium Copper
- Phosphor Bronze
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- Brass
- Chromium Copper
- Stainless 17-7PH
- Invar
- Magnetic: High Nickel

Some immediately available. Others rolled to order in 2 to 21 days. Can be supplied in coils or straight lengths with slit or filed edges—also cadmium plated.

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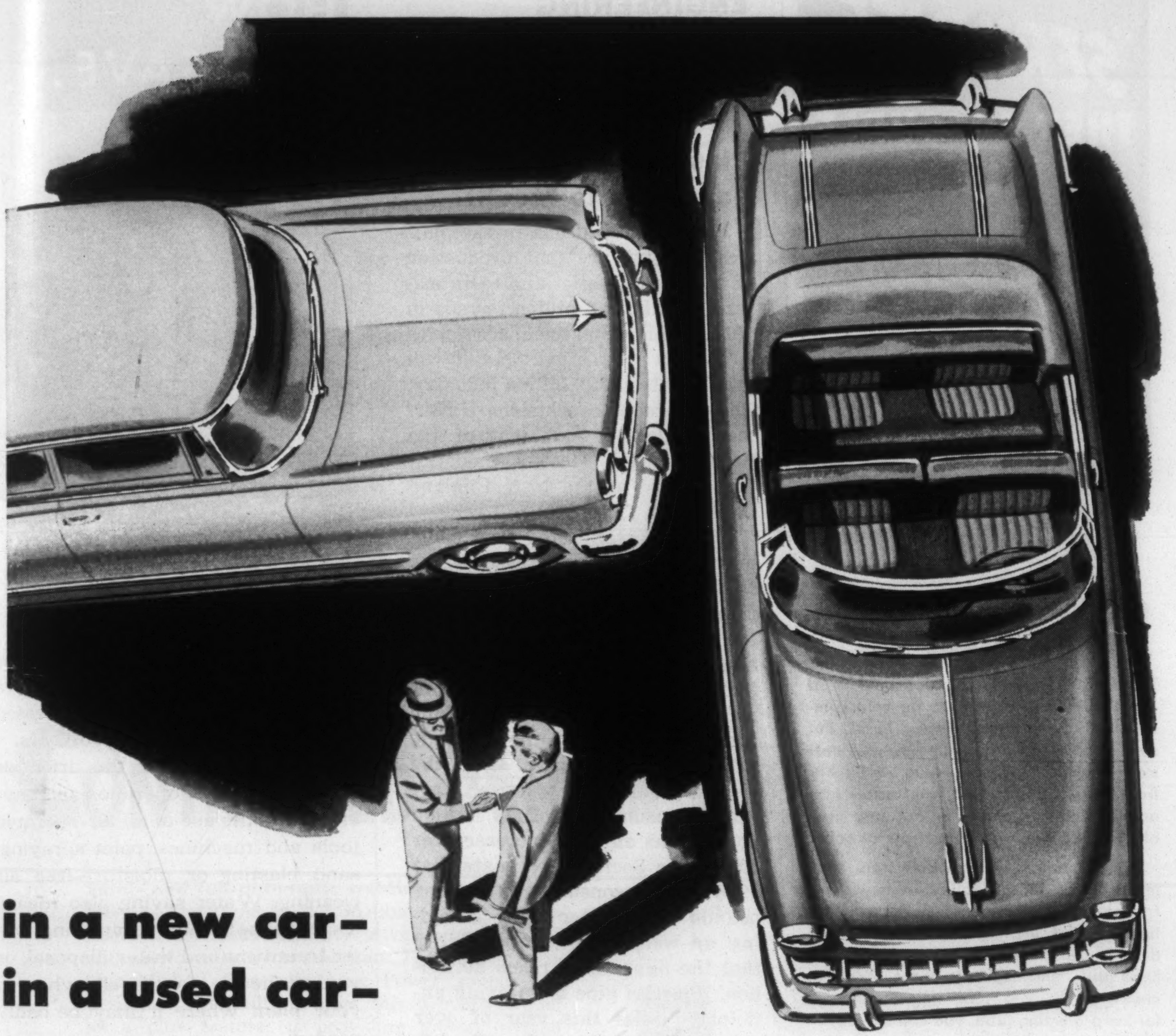

in a new car–
in a used car–

Stainless Steel sells and re-sells!

The Stainless Steel trim, molding and vital parts that add style and beauty to a car, inside and out, are features that help make the sale.

Stainless Steel has wide customer acceptance. It's easy to clean and keep clean. It's a tough, solid metal that will not corrode or dent and stands up to gravel, ice, salt and water.

The finish never fades and parts are easy to replace. Stainless Steel lasts the life of the car. It *sells* in a new car and it *re-sells* in a used car.

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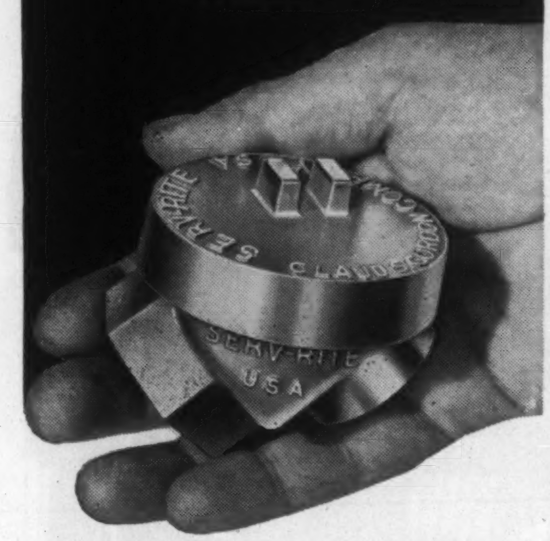

"SERV-RITE"
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HEAD

the head that's ahead in every way . . .

This new "Serv-Rite" thermocouple head is actually small enough to be held comfortably in the palm of your hand. But size is only one of the many features that make this thermocouple head really extraordinary. It is loaded with installation and service conveniences that any user of thermocouples will appreciate at once.

The body is of malleable iron, cadmium plated for durability. A new type friction lock assures easy removal or tightening of the cap — a quarter turn does it. An asbestos gasket makes the head dirt- and moisture-proof. With a choice of ½", ¾", or 1" IPS opening for the protecting tube, you can standardize on one style head.

The connector block is of a material especially selected to withstand, without damage, temperatures up to 900° F. in continuous service. Improvements over the conventional type of inserts greatly simplify the making of the lead wire connections. The complete thermocouple element, including connector block, can be easily withdrawn for inspection.

Install a "Serv-Rite" thermocouple head and see for yourself how much better it really is.

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4421

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MATERIALS ENGINEERING NEWS

Plastics Production Continues to Mount

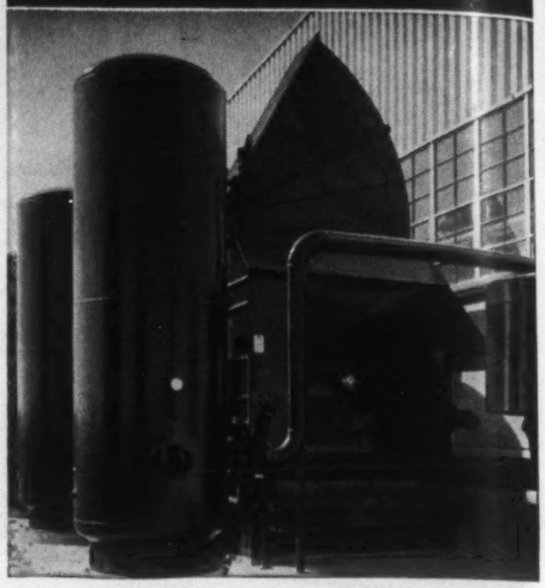
Present indications in the plastics industry are that production of synthetic plastics and resin materials will top 4 billion pounds in 1956. This total compares with 3.5 billion pounds in 1955 and will make plastics a $2 billion industry. These were the conclusions of Norman Anderson, president of the Society of the Plastics Industry, Inc., voiced at the New England meeting in October.

Mr. Anderson noted that moldmaking shows an increase over a similar period last year of approximately 12%. Considering the three to four month lag before actual production, this figure is an indication that this year's higher manufacturing rate will continue through the end of the year. A second noticeable gain is in the area of reinforced plastics. Last year's consumption of 49 million pounds was an 80% increase over 1954. The Society's estimate that 1956 would consume 73 million pounds of polyester resin is holding up well, with the possibility that the figure may reach 80 million. Plastics pipe is enjoying anticipated sales this year of over $50 million, compared with $45 million last year.

Rubber Developments—Synthetic and Natural

Synthetic rubber whose structure duplicates that of natural rubber is now in pilot plant production at a new plant of Goodrich-Gulf Chemicals, Inc. at Avon Lake, Ohio.

Ameripol SN, as the material is called, will be made available to other companies for testing purposes. So far, it has been tested principally by B. F. Goodrich Co. in the manufacture of large truck tires. Tires made entirely of Ameripol SN are giving highway service and mileage in fleet operations comparable to that



HOW YOU SAVE . . .

. . . getting drier Compressed Air

Direct saving in the cost of cooling water saves the price of the Niagara Aero After Cooler (for compressed air or gas) in less than two years.

Extra, for no cost, the drier air gives you a better operation and lower costs in the use of all air-operated tools and machines, paint spraying, sand blasting or moisture-free air cleaning. Water saving also means less expense for piping, pumping, water treatment and water disposal, or you get the use of water elsewhere in your plant where it may be badly needed.

Niagara Aero After Cooler assures all these benefits because it cools compressed air or gas below the temperature of the surrounding atmosphere; there can be no further condensation in your air lines. It condenses the moisture by passing the air thru a coil on the surface of which water is evaporated, transferring the heat to the atmosphere. It is installed outdoors, protected from freezing in winter by the Niagara Balanced Wet Bulb Control.

Write for Bulletin No. 130.
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"AUTOMATES" Welding Quality...

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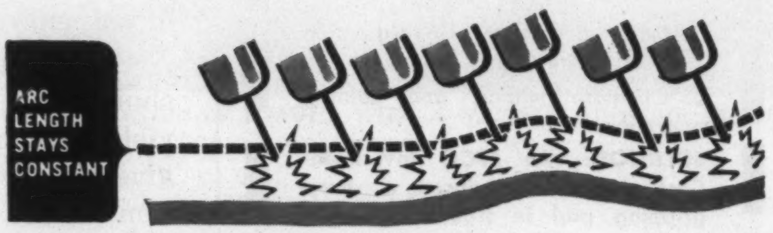
CONTROLLED ARC POWER SUPPLY

Semi- and full-automatic welding are representative of the trend to automation. Today the demand is for **dependability** in operation coupled with **uniformity of production.** The constant voltage M & T Controlled Arc Power Supply was designed and built to meet this demand — and, as a plus feature, is providing greater overall welding **economy.**

UNIFORM PRODUCTION Operating variables are eliminated. Instant starting and recovery — precise and automatic arc control — a steady arc voltage — uniform penetration with less undercutting — all assure an even bead shape and an even rate of deposit. The M & T Controlled Arc Power Supply used with a constant speed wire feed results in faster and more uniform production of high quality weldments.

OVERALL ECONOMY Installation costs are low, lighter and easier installed input wiring and switches being used. Input current requirements are less; no external voltage controls are needed; welding is completed faster with fewer rejects.



DEPENDABLE OPERATION The use of highest quality electrical components with a minimum of moving parts assure trouble-free operation with little or no need for maintenance.

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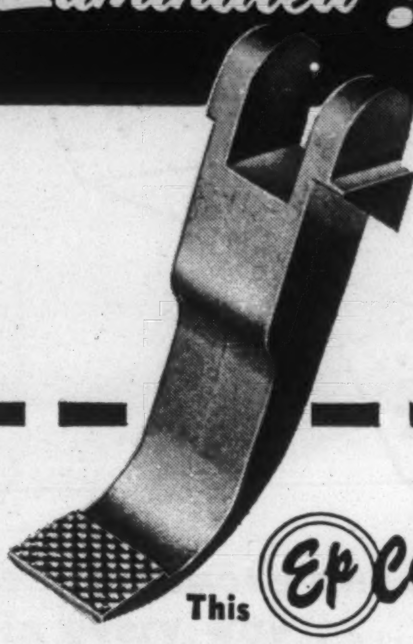

This EpCo

INVESTMENT CASTING

Proves the Point

PART: Paper Gripper for Printing Press

MATERIAL: Alloy Steel 4340

PROBLEM: To lower costs substantially below those of difficult and expensive forming methods yet retain the following features:

1. Sharp reverse knurling for more efficient gripper action.
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SOLUTION: An EPCO Investment Casting - - It produced a sharp gripping pad in true relationship to the center line of part.

CONCLUSION: When the shape of a part makes it difficult or expensive to perform special forming operations check an EPCO Investment Casting as a possible solution.

Send us drawings, samples and specification of parts for detailed process analysis and cost quotation without cost or obligation.

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MEMBER INVESTMENT CASTING INSTITUTE

For more information, Circle No. 502

of tires made wholly of crude rubber, the company has announced. Army Ordnance tests have reported military truck tires made of Ameripol SN superior to standard truck tires.

A team of Goodrich-Gulf scientists, working in the B. F. Goodrich Research Center at Brecksville, Ohio, discovered the new rubber in 1954, achieving for the first time a man-made rubber that has the same molecular structure as crude rubbers. The company has produced the new rubber in small quantities for more than a year while the new plant was being constructed.

At the same time, the Office of Defense Mobilization reports that two American scientists, Dr. H. J. Teas of the Agriculture Department's Research Service and Dr. R. S. Bandurski of Michigan State University, have achieved test tube synthesis of natural rubber by incubating radioactive rubber enzymes with acetic acid. They speeded up the formation of rubber by adding several compounds required for the activity of the enzymes being tested.

The method may provide a shortcut in the breeding of high-yield rubber trees, since it would give the breeders early information on the yield potential of different types. The development was also seen as having practical application in other branches of the Isoprenoid family.

Alumina is Produced from Abundant Clay

Anaconda Co. has found a way to extract alumina, the principal raw material of aluminum, from abundant domestic clays.

Clyde E. Weed, president, disclosed that a million-dollar plant was being built at the giant Anaconda, Mont. reduction works to test the alumina process on a commercial scale. The pilot plant

INVESTIGATE!

It's just good business to specify Promet Engineered Bronze Bearings, Bushings and Wearing Parts. For proof send prints and condition of operation for recommendations and quotations.

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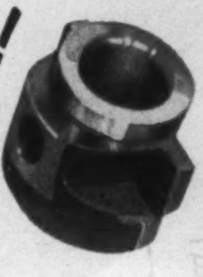

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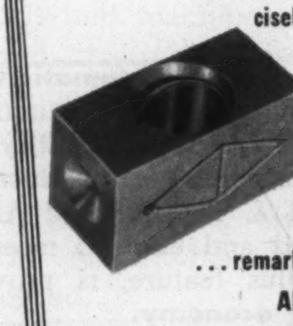

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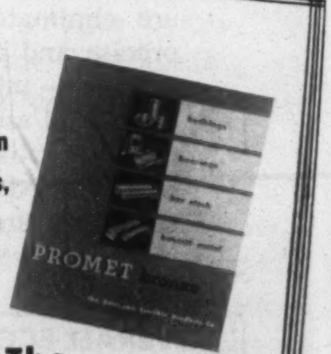

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Every day this worker shoots holes in his company's manufacturing costs. The 3M adhesive in his spray gun creates a structural sandwich that's inexpensive, featherweight and strong. Naturally this adhesive is a favorite with the comptroller.

3M adhesives like EC-1357 and EC-1177 bond a honeycomb paper core between thin metal skins. They produce rigid, more durable units from such light materials because they're tougher, more flexible. Many industries benefit: building, furniture, aircraft, railroad equipment and others.

These 3M adhesives are specially designed for this sandwich construction, thoroughly tested. They apply fast and easily, like the hundreds of varied 3M adhesives for other uses.

SEE WHAT ADHESIVES CAN DO FOR YOU!

Consult 3M research. Contact your 3M Field Engineer. Or for information and free literature write on your company letterhead to: 3M, Dept. 612, 417 Piquette Avenue, Detroit 2, Michigan.

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52 POWDER

PROTECTS and BRIGHTENS ZINC at LOWEST COST YET

LUSTER-ON 52 POWDER *is a low, low priced single dip, no-leach conversion coating for zinc plated surfaces.*

LUSTER-ON 52 POWDER was recently developed by The Chemical Corporation for automatic equipment where facilities are not available for added leaching and rinsing.

LUSTER-ON 52 POWDER gives a bright bluish hue; provides lasting corrosion protection against staining, tarnishing and white powder products.

LUSTER-ON 52 POWDER can *now* be used in cases where cost has prohibited use of chromates in the past. For instance, electrical conduit, conduit boxes, screws and builder's hardware, tools, electronic parts, air conditioning parts, automotive parts, cheap toys.

LUSTER-ON 52 POWDER is not only low, low in price, but eliminates expensive handling, space-consuming storage and carboy deposits.

Still available, of course — time-tested Luster-On liquid dips and coatings for all your needs.

Data Sheets and Prices on Request. Send in part for free processing.

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67 Waltham Ave. • Springfield 9, Mass.

For more information, Circle No. 392

will be completed next fall. It will process low-grade clays, as distinguished from bauxite ore, by leaching and high pressure filtration at the rate of 50 tons a day. From these clays it will produce 10 to 14 tons per day of alumina.

Mr. Weed and other officials stress that there are many problems in bulk production that do not show up in the test tube and there is no certainty the alumina resulting from the process will yield as much metal as the material now purchased from Reynolds Metal Co. They also emphasize that a process that might be economical for a smelter in northern Montana would not necessarily be practical for another company that had already established alumina plants near its smelters or a source of rich bauxite ore.

However, the implications for future aluminum plants, and for assuring the nation of alumina in defense emergencies, cannot be overlooked. The bulk of the world's aluminum is derived today from brown bauxite ore mined in the tropics. This is processed into white, sugary alumina, which in turn is reduced electrolytically to aluminum.

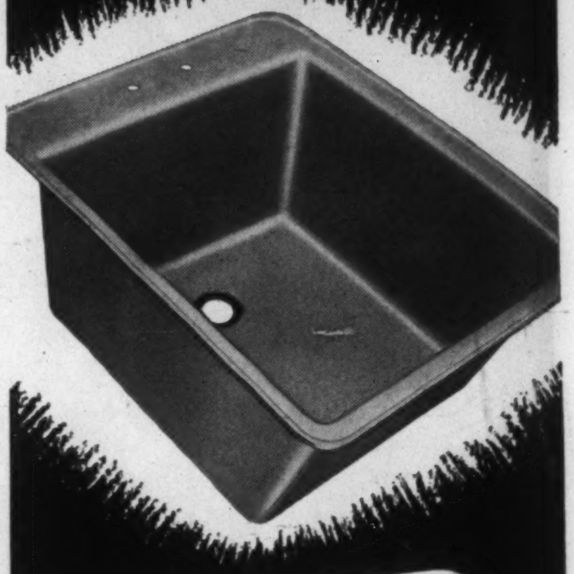
United States aluminum makers import about three-fourths of their bauxite, chiefly from Jamaica and Surinam. The rest is mined in Arkansas.

Special Plant Built to Process Titanium

The first specialized and exclusive facility for rolling and forging titanium will go on stream in the very near future. Since its beginning the titanium industry has utilized steel mills to convert titanium ingot into sheet, strip, billet and bar. The establishment, by Titanium Corp. of America, of this separate processing facility marks the first effort to handle the more demanding high strength

This is a laundry tub made better with

MOLDED FIBER GLASS



. . . extremely lightweight, exceptionally strong

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. . . unaffected by bleaches, harsh cleaning powders, disinfectants

It keeps water hot longer, because Molded Fiber Glass is a much better insulating material than cement or cast iron.

Molded in one operation from matched metal dies, this tub is just another example of a product made better with Molded Fiber Glass.

It is very likely that your company has a product which can be made better with Molded Fiber Glass. Write today for information.

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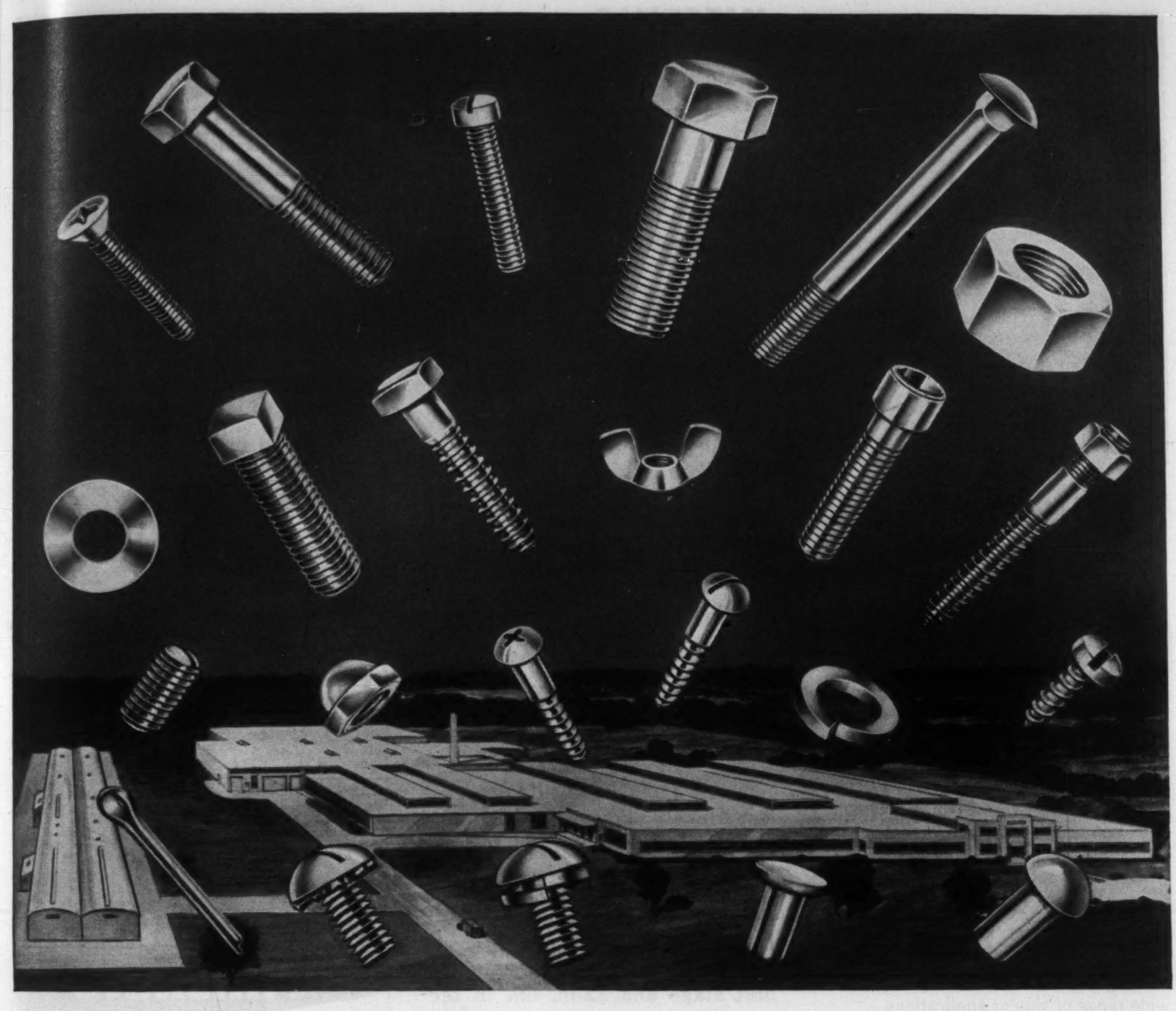

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Here are the reasons why stainless bolts, nuts, screws, washers and rivets by Harper will mean longer life, improved appearance to the equipment you make.

- Stronger in tensile
- Higher in yield strength
- Higher in nickel content
- More corrosion resistant
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You get all these Harper advantages at no added cost. Whether your order is large or small, it will be filled immediately from stock or promptly from the mill.

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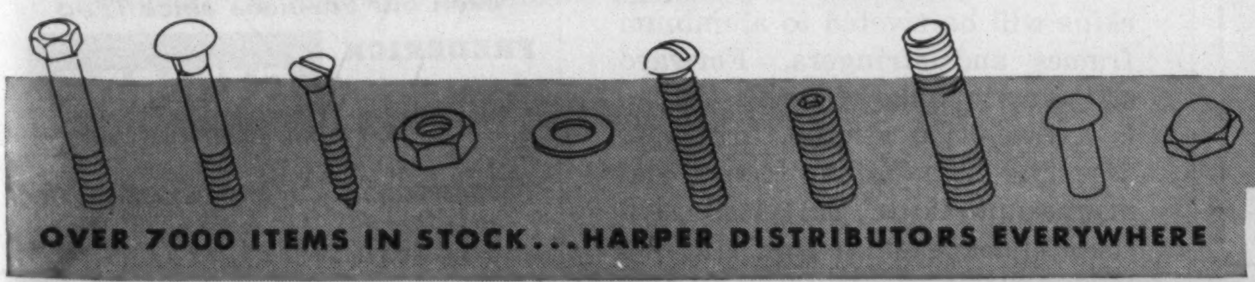

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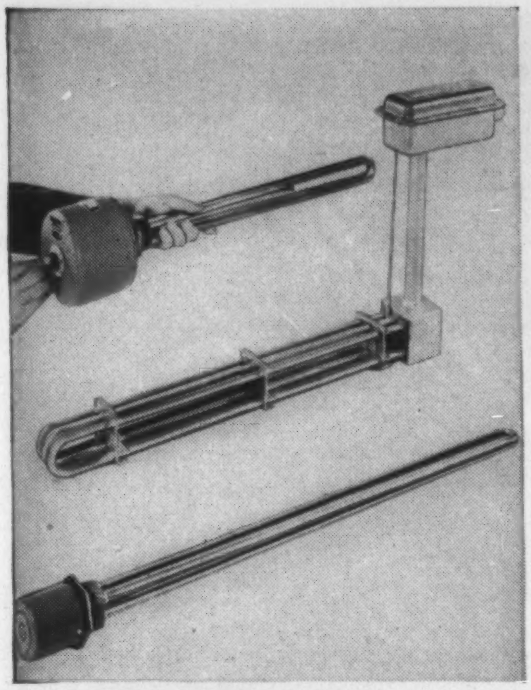

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Used for heating water, asphalt, greases, molten salts, pickling and plating baths, process kettles; for superheating steam and compressed air; for melting lead, solder, babbit; and for a wide range of similar applications.

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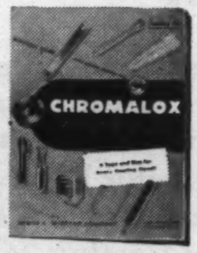
—for full information on the complete line of Chromalox Electric Heaters and controls.

For ideas on additional applications of electric heat, request Booklet F1550—"101 Ways to Apply Electric Heat."



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A-4467A

For more information, Circle No. 435

alloy products in a separate titanium rolling and forging plant.

The plant, a 400,000-sq-ft mill located at Toronto, Ohio, was purchased from Louis Berkman Co. It is presently being converted to suit the requirements of titanium processing. Special rolling mills and TMCA-designed vacuum annealing furnaces and heat treating equipment are being made for the new plant.

The first items the new plant will produce are special forged billets for jet engine wheels and heat treated alloy sheet for advanced jet fighters, bombers and ballistic missiles.

Materials Selected for Satellite Launcher

The Vanguard launching vehicle for the earth's satellite will be constructed principally of stainless steel, aluminum and magnesium.

The vehicle will be the first three-stage rocket to be developed in the United States and is about 72 ft long with 45-in. dia in the first stage and 32-in. dia in the second.

Only 14% of the 11-ton rocket is airframe structure; the rest is fuel, propulsion units and control equipment. The first stage will consist of two stressed-skin fuel tanks. The tank walls—actually the rocket skin—will consist of two aluminum skins and will be supported by two channel frames each and dome-shaped headers. The joint between the skins and headers will be reinforced by an aluminum extrusion. The metal parts will be fusion welded to provide a leakproof joint.

In the first stage engine section aft of the fuel tanks, magnesium skins will be riveted to aluminum frames and stringers. Forward of the main tanks of the first stage is a transition section, a riveted assembly of aluminum frames and magnesium skins. In this section the 45-in. dia of the first stage is

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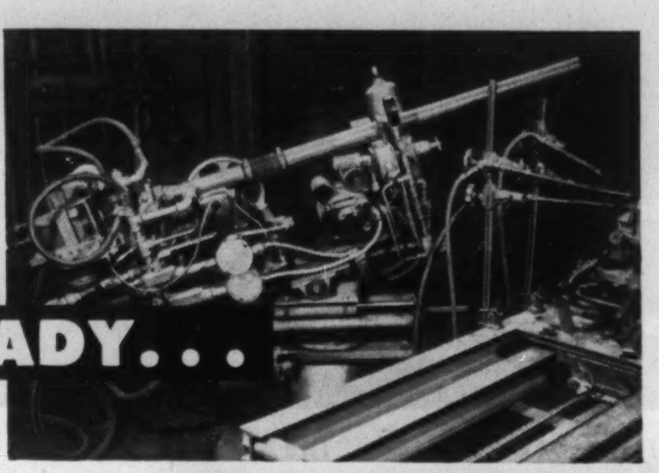
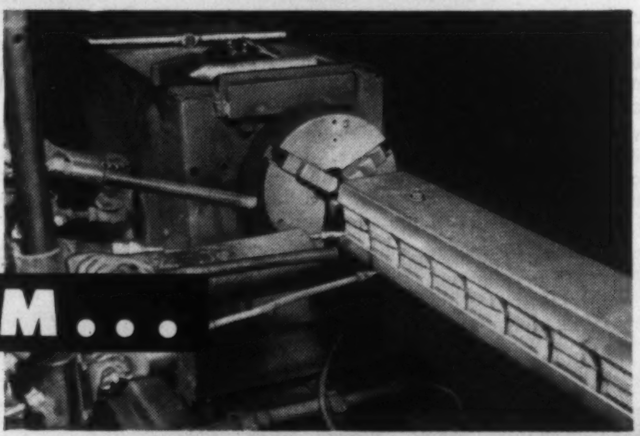
LINDE's Flame-Plating gun is operated entirely by remote control. At control panel (below) is operator, who observes process through safety-glass window. At right, Flame-Plating gun is seen as workpiece is secured in fixture (top), as gun is brought into range (center), and at the instant of a blast in the plating action (bottom).





FLAME-PLATE!

Not all guns shoot BULLETS ...this one gives metal parts EXTRA WEAR RESISTANCE

A dramatic and useful coating process for metal parts has been developed by LINDE engineers to provide extra resistance to wear and abrasion. This method, called Flame-Plating, utilizes a special, rapid-fire gun to apply an extremely hard coating of tungsten carbide or aluminum oxide on precision parts subject to unusual wear or fretting corrosion.

The Flame-Plating gun consists of a barrel and a mechanism for loading precise amounts of powdered coating material and explosive gases into a firing chamber. The powder—tungsten carbide or aluminum oxide—remains suspended in the gases until a controlled spark ignites the mixture.

The resulting detonation creates heat and pressure waves of tremendous force. These waves rip through the gas-and-powder mixture at supersonic velocity. The particles are hurled against the work with terrific impact. They fuse together and build up until the desired thickness is obtained.

The temperature of the workpiece seldom exceeds 400 degrees F. Thus precision parts can be Flame-Plated without risk of changes in physical dimensions or metallurgical properties. Coatings can be Flame-Plated in thicknesses from .002 to .010 inch, and finished to 0.5 microinches rms. Practically all metals can be Flame-Plated.

The extra resistance of Flame-Plated parts to wear, abrasion, and fretting corrosion has been proved in actual service. Vital parts in aircraft and automotive power plants, hydraulic systems, and heating units, as well as textile and canning machinery, plug and ring gages, bearings, and seals have all had their useful life greatly extended—and economically, too—with Flame-Plating by LINDE. Find out how Flame-Plating can help you improve your own design. Write for a free copy of the booklet, "Flame-Plating," F8065. Address "Flame-Plating, Department N-12."

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A Division of Union Carbide and Carbon Corporation

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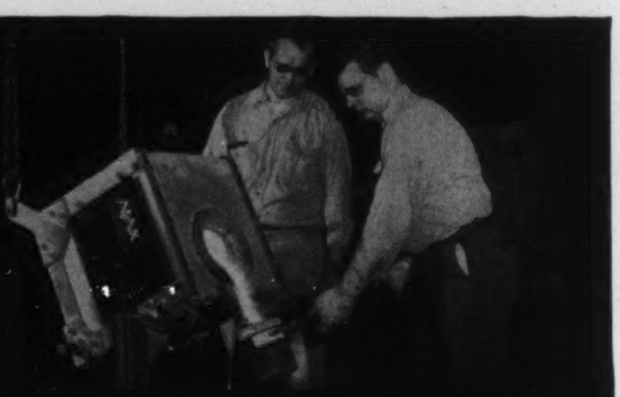
Flame-Plating by *Linde*

For more information, turn to Reader Service Card, Circle No. 542

For more information, turn to Reader Service Card, Circle No. 398

how Ajax
induction
melting
meets investment
casting
requirements



. . . at Precision Metalsmiths, Inc.

The special melting requirements of precision investment casting are an old story to Precision Metalsmiths, Inc., Cleveland, Ohio. This one foundry melts ninety-two different ferrous and nonferrous alloys . . . often in small quantities. Many of these alloys require unusual protection from contamination during melting—and substantially all are made to extremely close analyses. Carbon content in some must be kept below .04%.

Only an Ajax-Northrup converter-powered induction melting unit could meet the requirements of versatility, purity, and economy so well. That's why four Ajax units now satisfy all the company's production needs. Three 17 pound capacity portable furnaces are each powered by 20 kw Ajax-Northrup spark gap converters; and the fourth, a fifty pound capacity tilting furnace, is powered by a 40 kw Ajax-Northrup converter.

Precision Metalsmiths standardized on Ajax because Ajax-Northrup units cost far less to operate and maintain in operation. They're ruggedly constructed to take the toughest kind of service in stride. Normal converter maintenance is limited to cleaning the gap chamber and inspection at three month intervals. For additional details, write Ajax Electrothermic Corp., Trenton 5, New Jersey, requesting Bulletins 14-B and 27-B.

Associated Companies: Ajax Electric Company—Ajax Electric Furnace Co.—Ajax Engineering Corp.

AJAX NORTHRUP SINCE 1916

INDUCTION HEATING-MELTING

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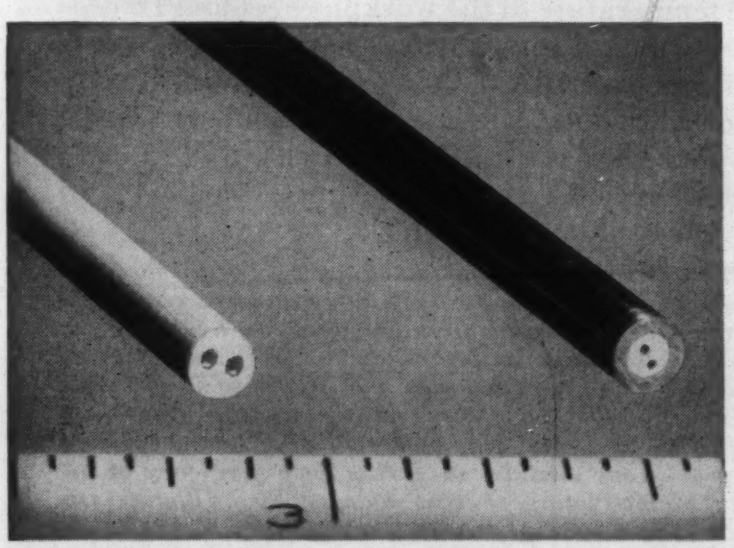

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reduced to the 32 in. of the second stage, which is about 31 ft long.

The forward section of the second stage will contain the master guidance mechanism for the entire vehicle. It will also carry, enclosed within its forward end, the third stage engine and the turntable on which the third stage, carrying the satellite, is mounted. The second stage tanks, because of the corrosive nature of the propellants—nitric acid and unsymmetrical dimethol hydrazene, will be fabricated from 17-7 PH stainless steel. The forward section of this stage, containing the electronic controlling units and mechanisms for the entire rocket assembly, will be made of aluminum and magnesium.

Both the empty rocket bottle and the satellite eventually will re-enter the earth's lower and denser atmosphere at speeds somewhat above 25,000 ft per sec and will burn and disintegrate as a result of the heat generated by their passage.

Coast ASTM Meeting Attracts Wide Interest

Practically every type of engineering material was covered at the American Society for Testing Materials' Second Pacific Area National Meeting, held in Los Angeles in September. More than 200 papers were presented at 43 technical sessions on research, properties, uses and methods of testing.

Strong participation by the representatives of the aircraft and allied industries made the meeting particularly noteworthy. Also, the Subcommittee on Radiation Effects of the Atomic Industrial Forum joined with the ASTM Committee on Radioactive Isotopes in sponsoring a timely and important Symposium on Radiation Effects on Materials.

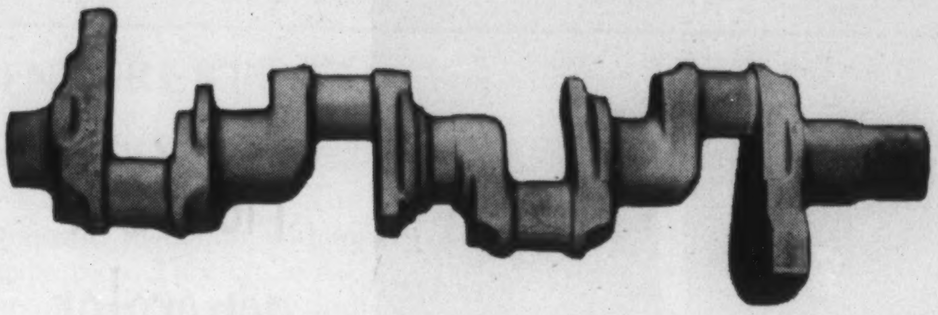
A high point of the meeting was the talk given by Lt. General Clarence S. Irvine, who spoke on

whether you think in terms of

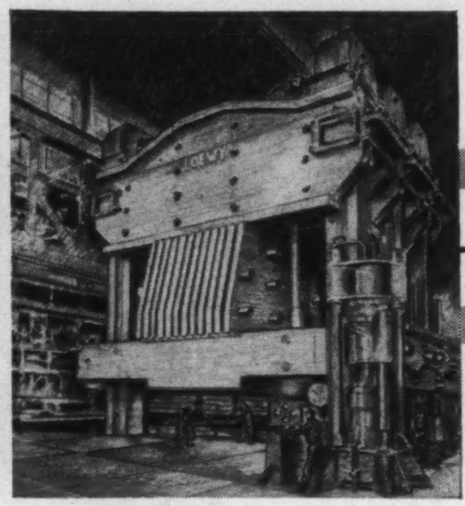
Horsepower

or

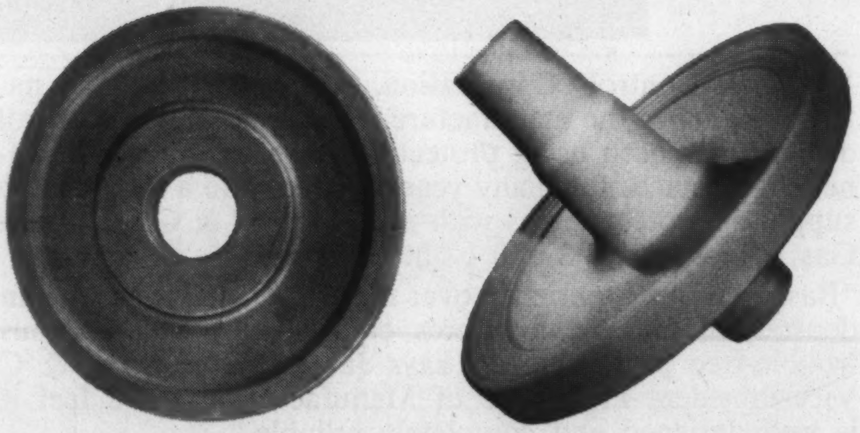
Thrust



The crankshaft is the backbone of the piston-type engine. Illustrated above is the crankshaft forging for the most powerful piston-type aircraft engine ever produced.



At the bottom left is a turbine disc forging made from high density heat resisting alloy, and next to it is a titanium compressor wheel forging for two of the most powerful jet engines yet produced.



The history of Wyman-Gordon's contribution to aircraft progress dates from the inception of the "flying machine". The jet age is now calling on the unparalleled resources of Wyman-Gordon, which include the widest range of hammer and press equipment and the greatest technical know-how in the industry. Larger and more intricate forgings than heretofore available of aluminum and magnesium are being produced on presses up to 50,000 ton capacity, and giant hammers are fulfilling the growing need for forgings of titanium, high density materials or so-called super alloys. Now, as for nearly 75 years, there is no substitute for Wyman-Gordon experience and ability for — Keeping Ahead of Progress.

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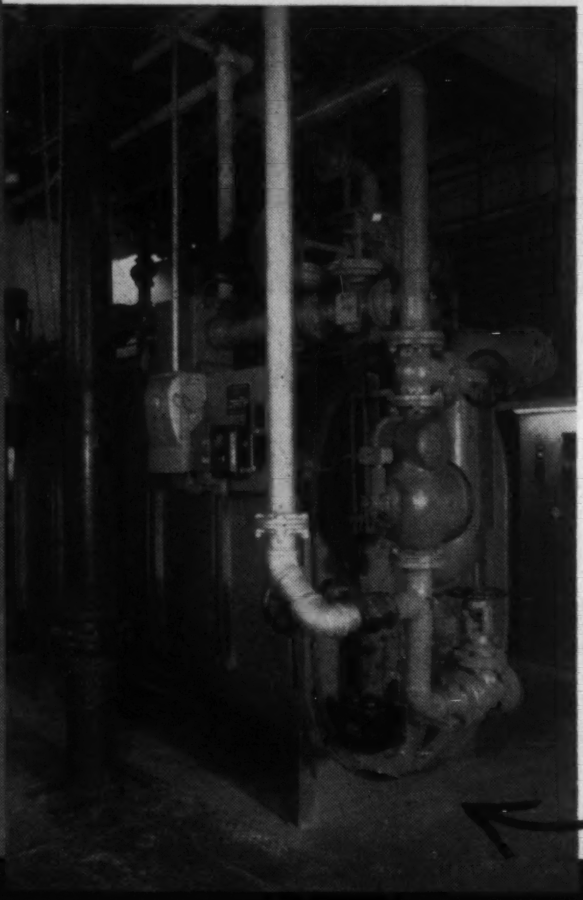

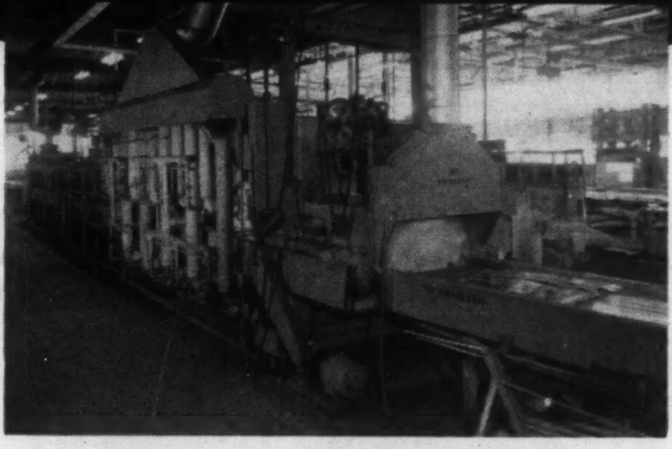

Here's a generator that's got what it takes

to anneal M & C clad metals

Metals & Controls Corporation, Attleboro, Mass., a national leader in the manufacture of clad metals and control devices, has been using protective gas atmospheres in annealing furnaces for many years. To provide a dependable supply of protective gas with economy, M & C selected a Gas Atmospheres' 8,000 c.f.h. Generator.

"Based on our experience over the years, we know we can depend on Gas Atmospheres equipment for continuous trouble-free performance," says James W. Fish, M & C Vice-President in Charge of Manufacturing. "We feel it is well designed and completely reliable."

If you use industrial gas in any amount — remember Gas Atmospheres Inc. builds generating equipment that's got what it takes.

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"Super Materials for Super Performance." He discussed the astonishing materials requirements of modern aircraft and the even more astonishing properties to be required of aircraft materials in the future.

The apparatus exhibit presented the opportunity of seeing at first hand many of the latest developments in research and testing devices. A trend toward nondestructive testing through the use of X-rays and radioactive isotopes and by sonic methods was indicated in many fields, especially metals. At the same time outstanding new machines showing many refinements in the older types of tests were also on display.

More than 2500 people attended the meeting and exhibit. Most of the technical papers and reports are being prepared for publication by ASTM in the near future.

Zirconium Capacity Up

Allegheny Ludlum Steel Corp. recently completed a new furnace for melting high purity zirconium metal which can produce a 2200-lb ingot and has a rated capacity of 50,000 lb per month. Believed to be the largest furnace in use for melting zirconium, the installation will allow a 100% increase in AL's production. The furnace is located at Watervliet, N.Y.

Another furnace now under construction will be put in operation before the end of the year. The company's rated capacity for production of zirconium ingots will then stand at 125,000 lb per month.

Induction Stirrers Improve Cast Steel

Induction stirrers, previously used only in steel mills for the production of steel ingots to be converted into shapes by rolling or forging, will be employed by GE to produce better alloyed steel castings. Use of the stirrers is

THORIUM

URANIUM'S INTERESTING STEPCHILD

Teddy Roosevelt was President. The age of Victorian splendor was in full swing. And incandescent gas lamps were lighting America. The heart of these glowing lamps was the gas mantle — made, for the most part, of thorium.

Lindsay was a famous name in the gas-light era, a major producer of gas mantles.

The manufacture of gas mantles calls for the impregnation of a knit fabric cone of ramie or rayon with thorium nitrate and cerous nitrate. The organic fiber is burned off, leaving a relic structure of thorium and cerium oxide which glows white hot in a gas flame.

Around 1920, gas illumination was largely supplanted by electric lighting. Demand for thorium dropped. Then came the atomic age. Thorium again became important because of its value as a reactor fuel breeder.

At the present, there are two systems in which thorium can be used as a fuel material breeder. One is the use of metal or a thorium-bismuth alloy; the other, a thorium oxide slurry reactor. Both procedures are being investigated by the AEC and private industry. It is believed that at the assumed burn-up rate of thorium oxide (one pound of ThO_2 for six megawatt hours of electrical energy) the thorium-rare earth industry is probably capable of handling domestic demands without excessive expansion. Thorium looks good as a reactor fuel for private industry because it is much more plentiful and economical than uranium.

So much for the Buck Rogers stuff . . . what's ahead for thorium, excluding the energy field? The answer to that is "plenty" and chances are it can be of immense value to you—it already is in a number of industries.

The most common thorium salts are the nitrates, oxides, fluorides and chlorides. Lindsay produces all of them in purity ranges from that required for ordinary technical use to the most critical "reactor" grade where extremely high purity is a must.

Let's see how some of these salts are being used in industry. Perhaps you'll see a potentially profitable use for them in your own operations.

$Th(NO_3)_4 \cdot 4H_2O$—Manufacture of incandescent gas mantles. A starting material for other thorium compounds and thorium metal. Nitrate is the standard commercial thorium salt.

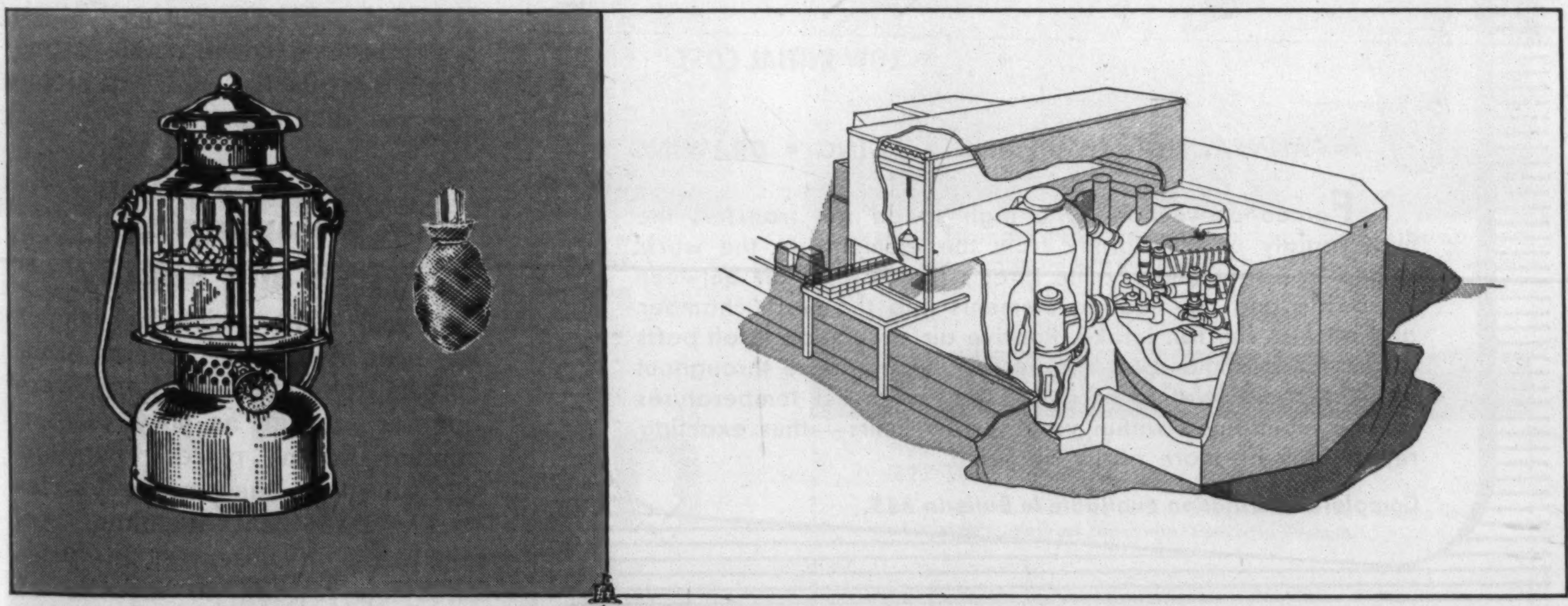
ThO_2—Thorium oxide has the highest melting point of any metallic oxide (3220°C) and has use as a refractory material. It is also used with lanthanum oxide in the production of "rare-element" optical glass for unbelievably accurate aerial camera lenses. It is a source material for making thorium metal. The AEC and several private companies are studying its use in a thorium oxide-water slurry reactor. It has some use as a catalyst.

Thorium-magnesium alloys have high strength, good creep resistance and elastic modulus values in the 600-700°F temperature range and are used in jet engine castings, supersonic air-frame constructions and satellite rockets where high temperature service is required.

Thoriated tungsten (tungsten containing 1 to 2% ThO_2) is used as a filament in electron tubes and as non-consumable electrodes in inert gas-shielded arc welding.

Lindsay is the oldest and largest producer of thorium compounds for the government and private industry but we don't make thorium metal. Naturally, since we've been in the business 54 years, we've learned a good deal about this remarkable, versatile element. Data is available to you and the counsel of our technical staff is yours for the asking.

We feel certain that thorium has enormous potentials in a variety of industries and we want to share our knowledge with you. If you think that thorium chemicals may be useful in improving one or more of your products or processes—or in the development of new products—let us be of help.



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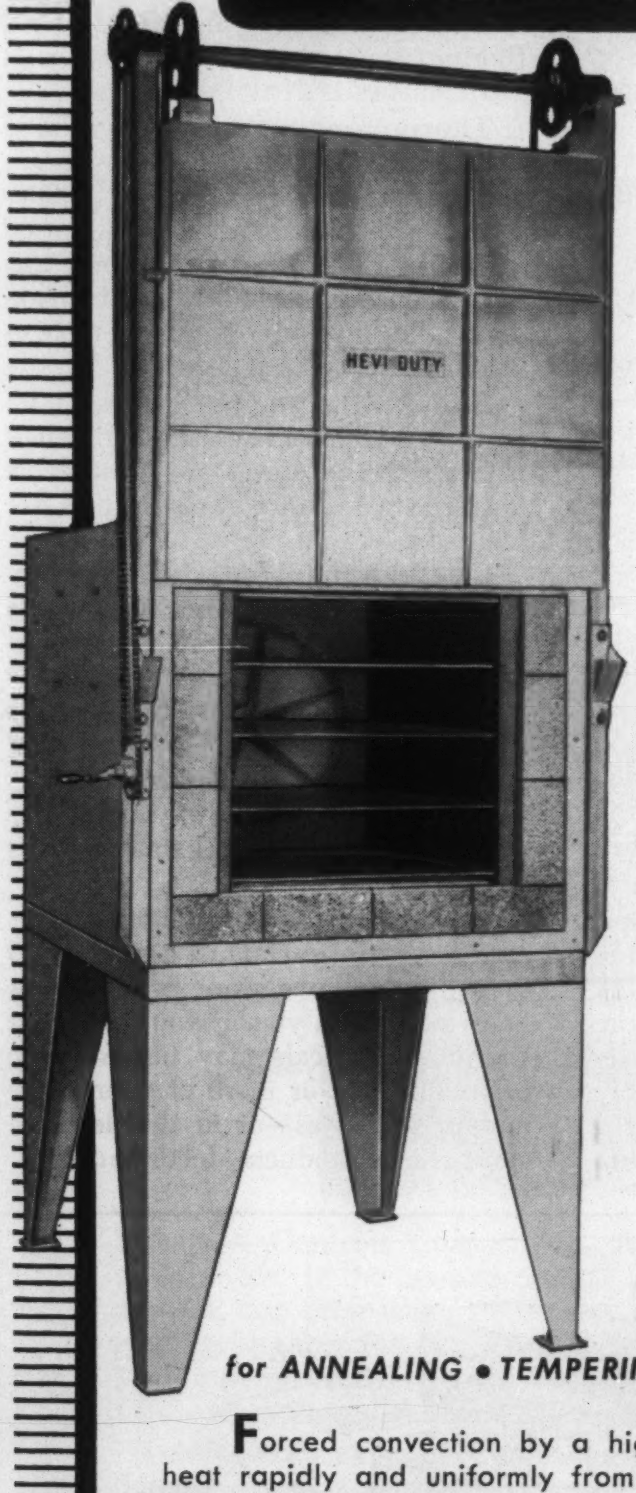

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Complete information available in Bulletin 355.

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said to decrease the time necessary for refining steel prior to pouring.

The induction stirrer is actually a water cooled coil which is suspended about 1 in. below a stainless steel furnace bottom. A varying magnetic field induces eddy currents in the molten bath of metal, and the resultant field reacts with the excitation field to create a stirring force.

Some of the advantages are: almost complete removal of such impurities as phosphors and silicates with little loss of metal; reduction of sulfur impurities to one-third of conventional levels; better control of grain size in austenitic steel due to uniform furnace temperatures; and reduction of refining time.

Navy Chromium Steel Has No Columbium

Continuing investigation by the Naval Research Laboratory into the replacement of austenitic steels by ferritic grades for high strength, elevated temperature applications has led the Navy to develop a 12% chromium steel modification without columbium. Modified 12% chromium steels have received considerable attention, particularly for use in steam and gas turbines.

What's Happening in Prices and Supply

Copper—The price of copper has been steadily decreasing since last March when smelters were quoting as high as 55½ cents a pound. Recent price reductions have brought the smelters' price as low as 36 cents a pound. According to one observer, this price situation is due to months of heavy production unmatched by a corresponding rate of consumption. From a high of 138,600 tons last January, consumption dropped to 81,000 tons in July. Fabricators

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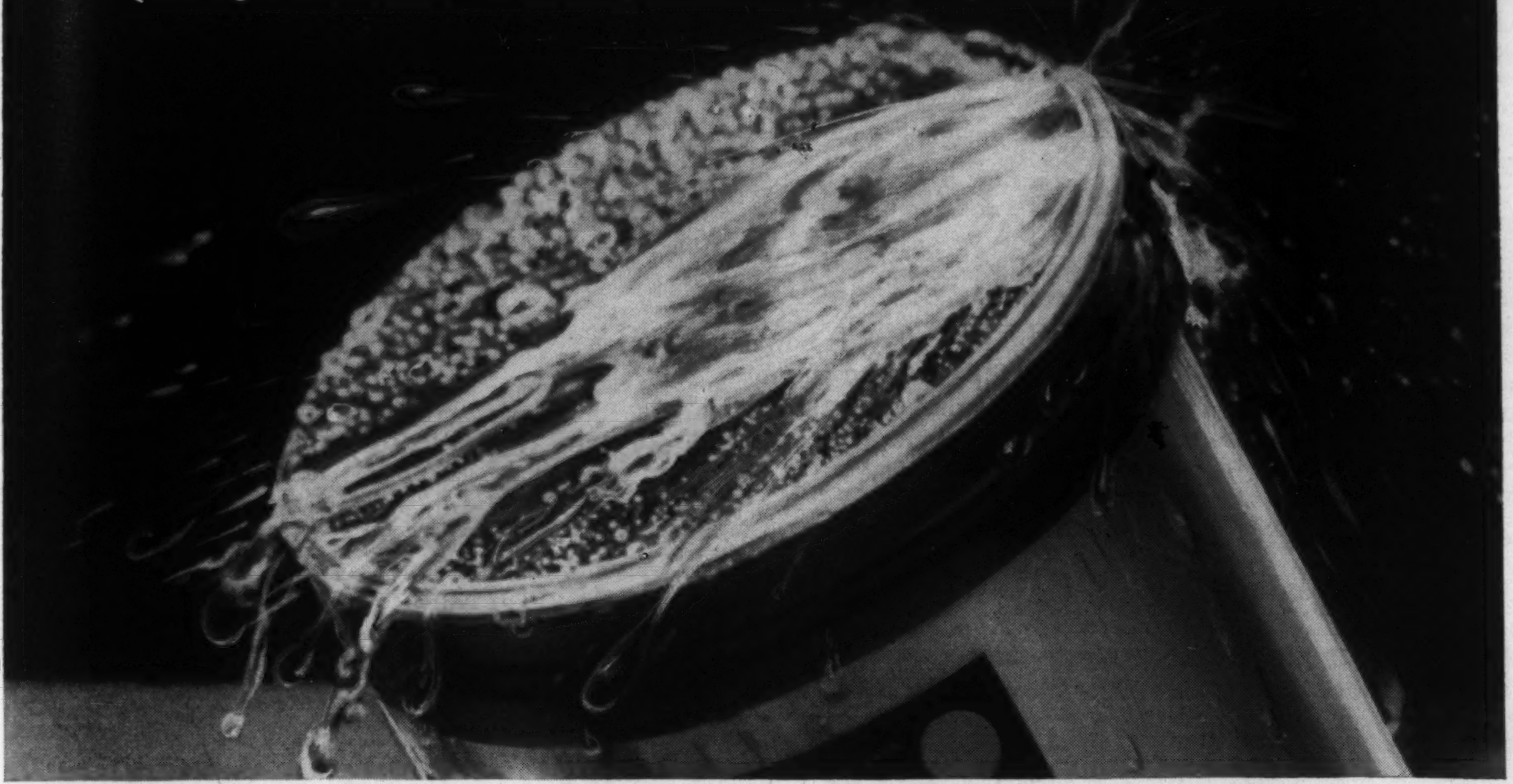

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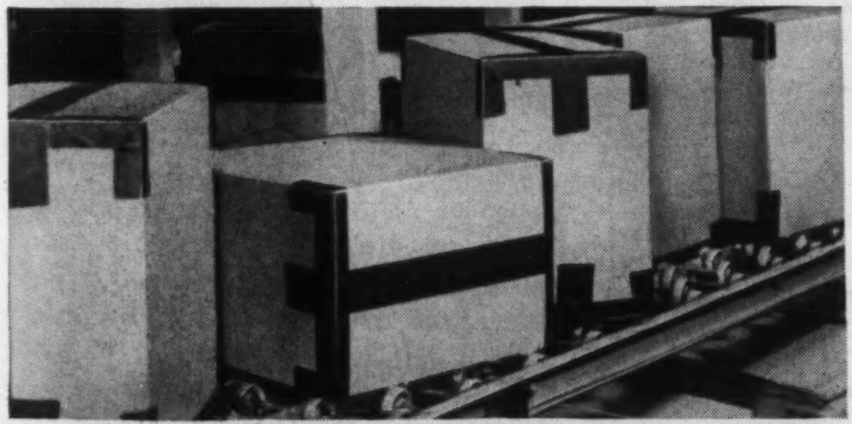

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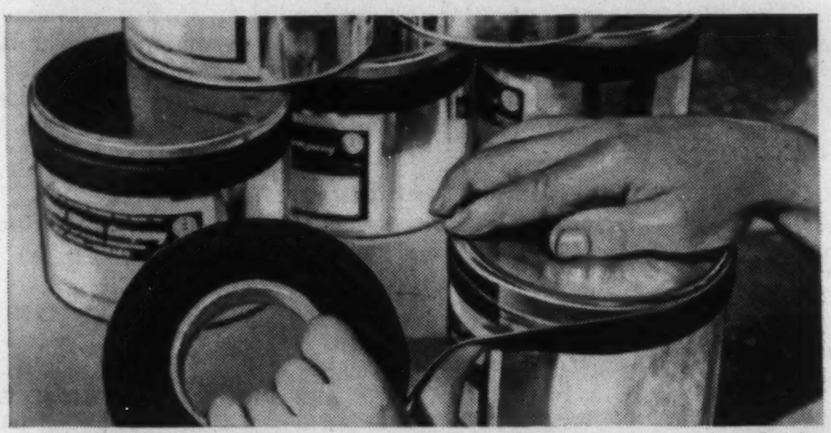

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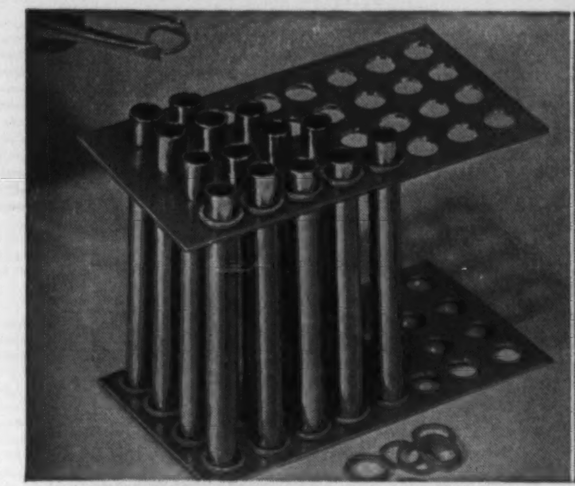

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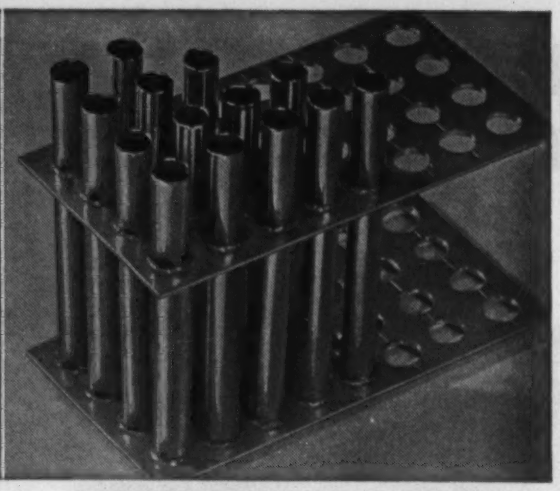

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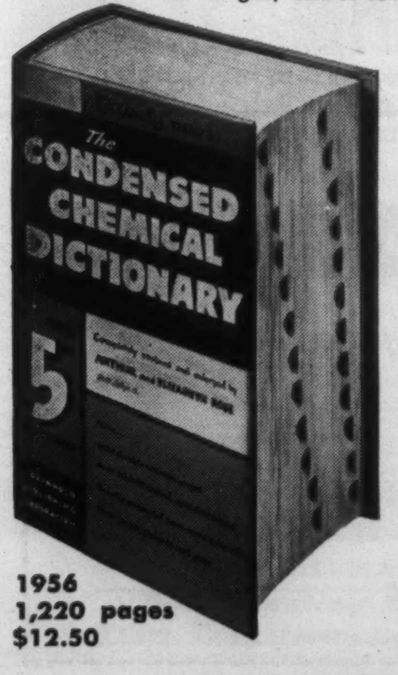

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MATERIALS ENGINEERING NEWS

stocked up during the spring and summer as a hedge against threatened widespread strikes, but no major strikes developed. The price of electrolytic copper has also been reduced by Phelps Dodge Corp. to 36 cents a pound. This represents a cut of 4 cents a pound and is the first change in producer price for copper since early July. Phelps Dodge also announced a 7½% decrease in copper output, from 24,000 tons a month to 22,150 tons a month.

Lead—The consensus among market sources is that prices are likely to remain steady this quarter. However, with smelters' and refiners' stocks increasing and continuation of the Government's stockpiling policy unlikely, the longer term outlook favors still lower prices.

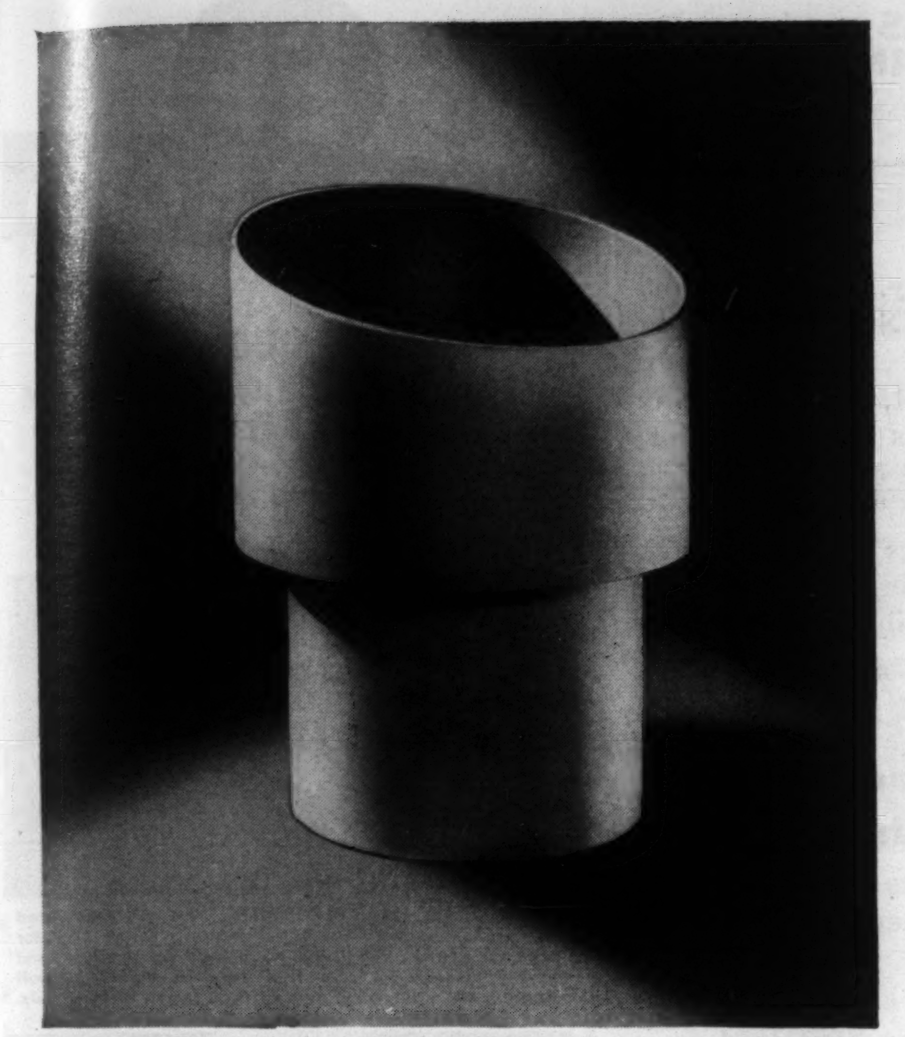
Nickel—The tight situation in the nickel market will probably improve after the first of the year because the government stockpiles are reported to be about up to their goals and more metal will be released for industrial use. Actual figures show that nickel consumers are getting about 7% more nickel this quarter, and that 75 million pounds of nickel will be available in the first quarter of 1957. This represents a 15 million pound increase over this quarter.

Steel—Eugene E. Grace, chairman of Bethlehem Steel Corp., announced that more steel price increases are "coming." Exactly how much and when was not disclosed. On the other hand, Roger M. Blough, chairman of U.S. Steel Corp., indicated that no price increases were being planned "at this time."

Wood—Prices for fir plywood have been steadily declining. Producers were recently quoting a price of $67 a thousand square feet for basic Douglas fir plywood, compared with $88 in February of this year.

Zirconium—Zirconium Corp. of America has recently cut the cost of pure zirconium oxide by 25%, paving the way for use of stabilized zirconia as an economical

To make equipment more dependable, use C-D-F electrical insulation!



C-D-F HANDLES THE COMPLETE JOB An oil circuit breaker component is made from two Dilecto laminated plastic tubes, with a threaded ring joining the assembly. From raw materials to finish machining C-D-F does it all!

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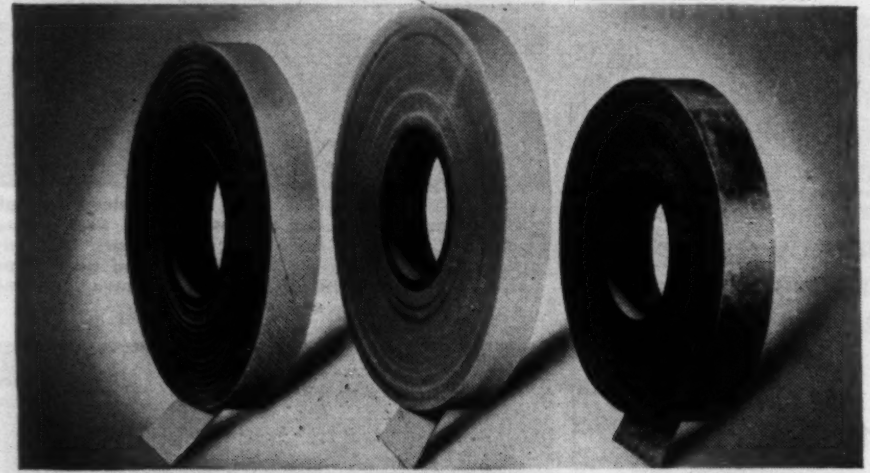

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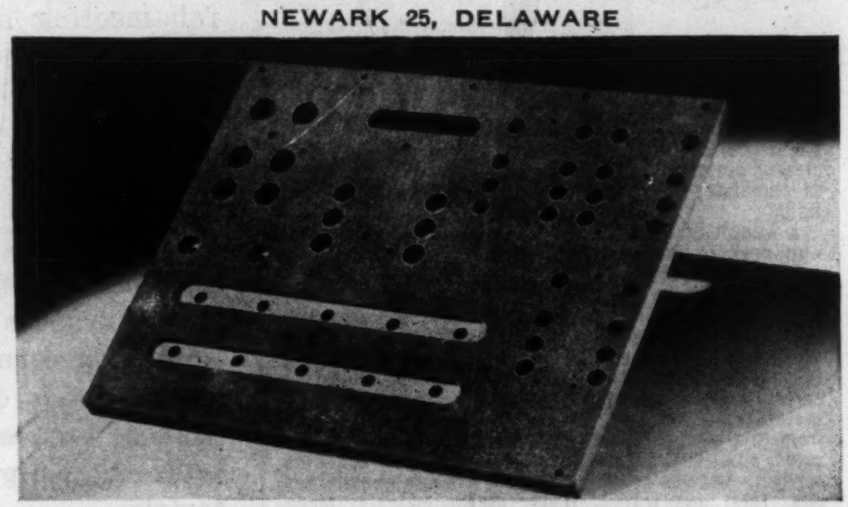
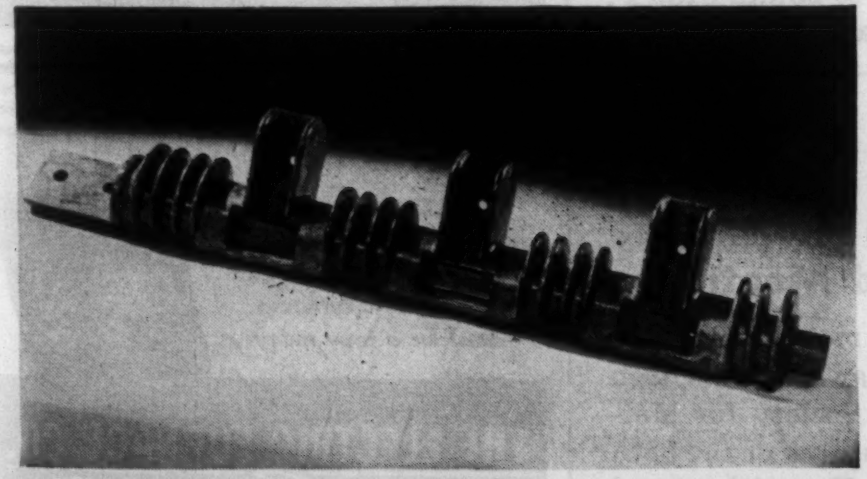


C-D-F UNDERSTANDS THE ELECTRICAL INDUSTRY'S NEEDS Precisely machined to close tolerances, Dilecto panel boards guarantee dependable insulation, help designers save space. New 1955 Dilecto catalog is yours for the asking, lists all new grades.



C-D-F MOLDS MANY SPECIALTIES This shaft insulator for a circuit breaker is molded from C-D-F's cloth-based industrial thermosetting plastic, Celoron. Note complexity of mold, clean detailing. Celoron has high impact strength, is used in switchgear.

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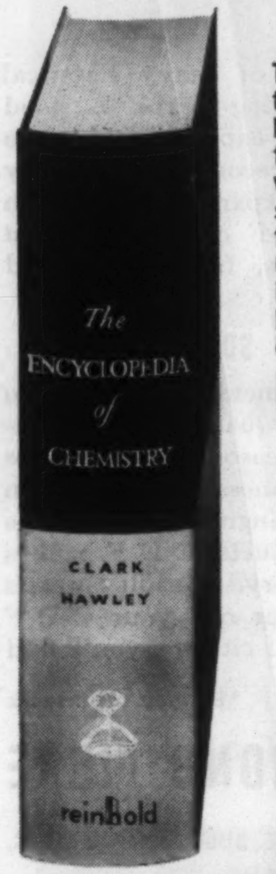

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super refractory. General Manager Edward C. Sargent said that the revamped price structure would, in effect, "move zirconia from the status of a laboratory curiosity to that of an economical, commercial item." He said "many prospective users have been marking time because costs have been considered prohibitive."

Solar Furnaces May Do Their Share

Solar furnaces may contribute to the development of new alloys and cermets.

An analysis of the value of solar furnaces is contained in a paper presented at the American Society of Mechanical Engineers' fall meeting in Denver. Because solar furnaces generate temperatures of more than 6000 F in an atmosphere free of burning gases, electrode fragments and other impurities, researchers can heat samples without exposing them to unwanted contamination. Use of solar furnaces in developing and producing cermets and other special alloys is of particular significance because of the present interest in high temperature materials.

The largest solar furnace installed to date is a French unit 200 ft in dia. Although it is theoretically possible to obtain 8130 F, losses cut the practical reading to 6330 F.

Metals Men Honored at Cleveland Meeting

Leaders in the metals field were honored at the awards luncheon of the American Society for Metals, one of the features of the 38th National Metal Exposition and Congress held in Cleveland in October.

Clarence B. Randall, retired

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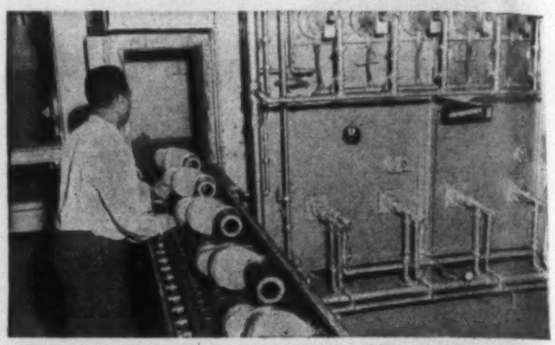
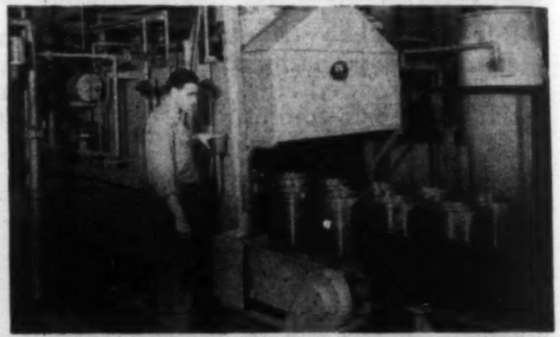


SCALE FREE HEAT TREATING. This EF gas fired radiant tube installation with 3 heating zones, elevator type oil quench and a 2-station washing machine and rinsing equipment, scale free hardens heavy aircraft motor parts, uniformly, automatically and continuously.



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BULLETIN No. 461
shows typical installations of EF Gas-fired, Oil-fired and Electric Furnaces
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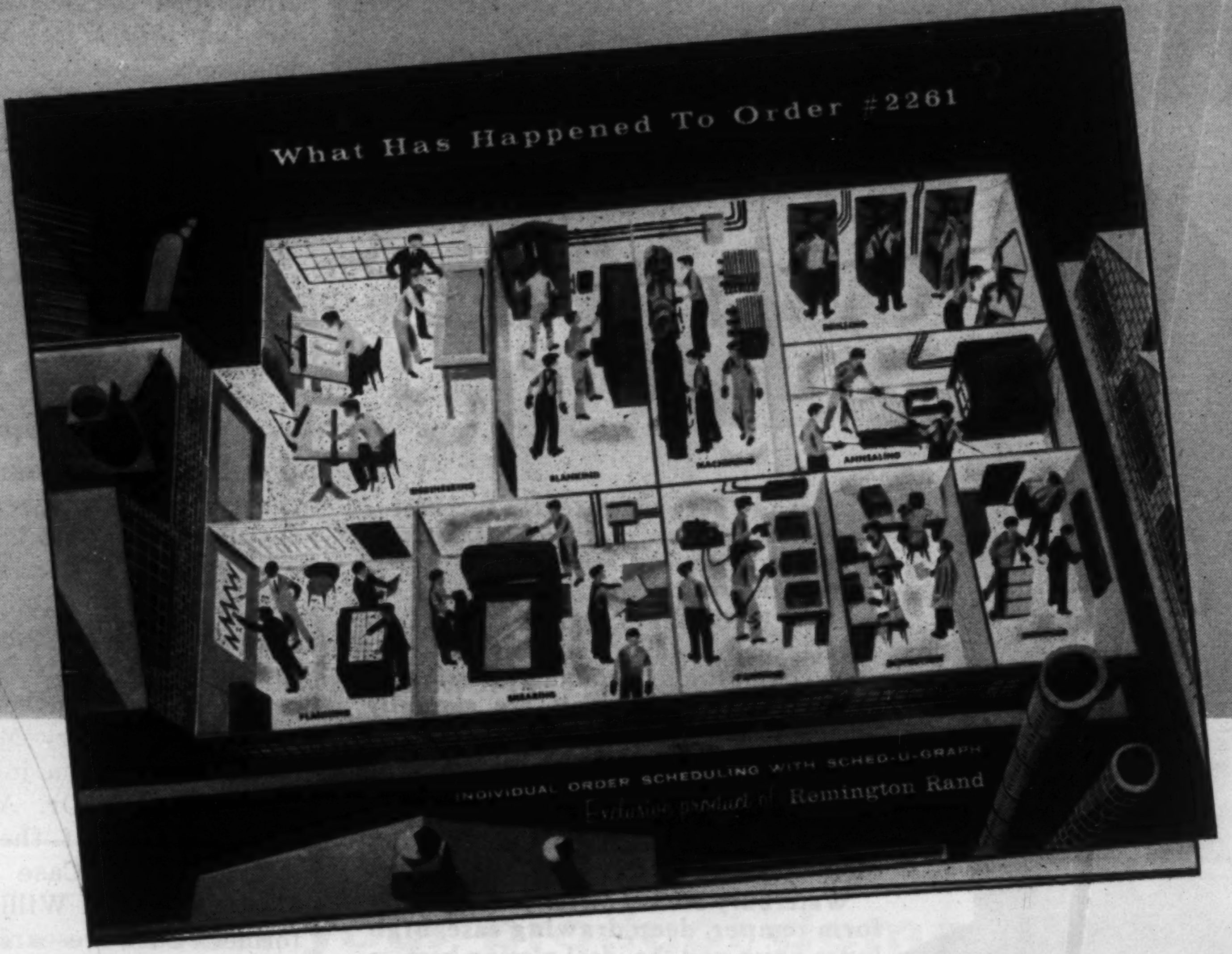
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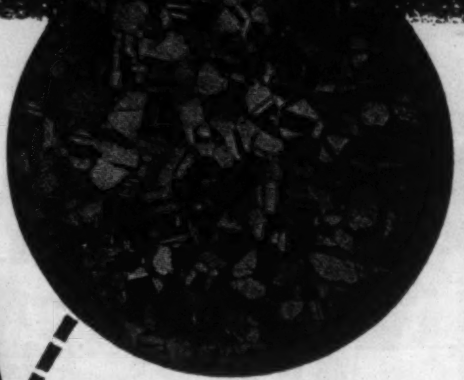
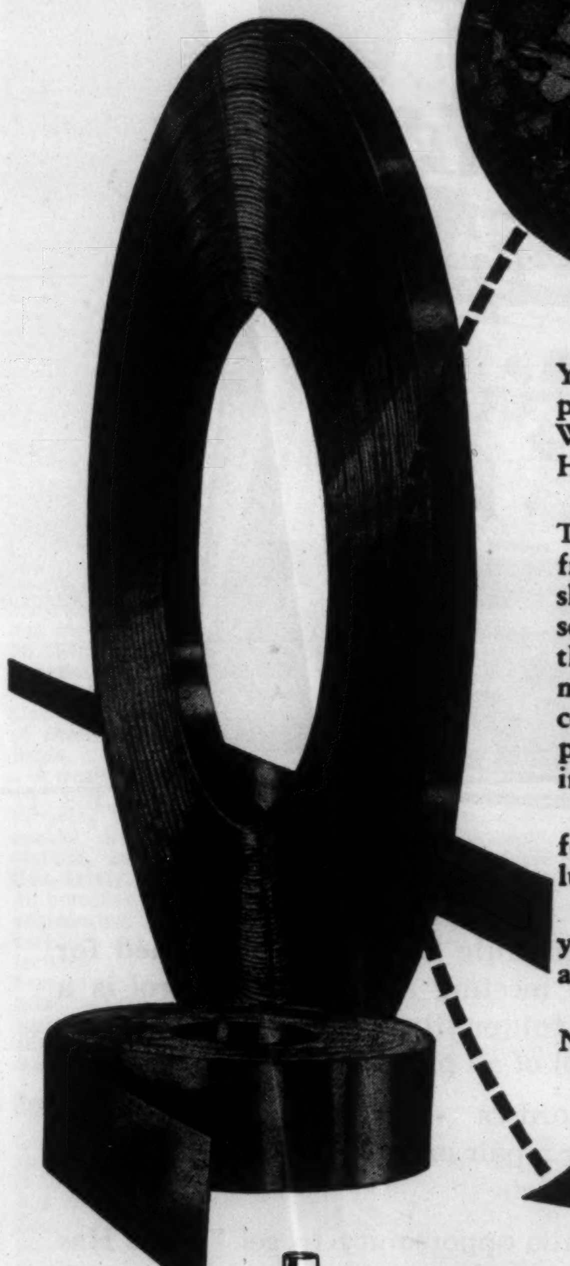


Microphotograph shows grain size and structure uniformly maintained in Waterbury Nickel Silver.



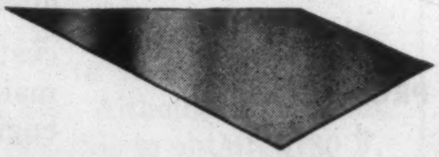
You can expect consistently successful performance from every coil or sheet of Waterbury Rolling Mills Nickel Silver. Here is the reason why.

WATERBURY'S QUALITY CONTROL keeps a close watch on the metal from composition, through processing, to shipment. Raw materials are carefully selected, combined and processed under the constant scrutiny of Waterbury's metallurgical laboratory. This assures a consistency of grain size and structure plus physical properties that give you uninterrupted success in your application.

Waterbury Nickel Silver provides uniform temper, deep drawing ease, high lustre finish and the ideal plating base.

Remember also, that Waterbury's 47 years of metallurgical experience is available to help you on specific problems.

Specify Waterbury Rolling Mills Nickel Silver. You'll get fast delivery.



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WATERBURY ROLLING MILLS, INC.
Established 1906
MAIN OFFICE: Waterbury, Conn., Tel. Waterbury 4-5131

WR-9

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chairman of the board of Inland Steel Co., received the first Distinguished Service Award given by *American Metal Market.* In a message, President Eisenhower praised Mr. Randall for his "long record in the metal industry and . . . continuing guidance in charting our nation's foreign economic affairs."

Edgar H. Dix, Jr., assistant director of research at the Aluminum Co. of America's laboratory at Pittsburgh received the Albert Sauveur Achievement Award. William H. Eiserman, national secretary of ASM, was chosen by the society trustees for the ASM gold medal.

Charles M. White, new board chairman of Republic Steel, was given the ASM research medal for his sponsorship of metallurgical research and development.

The ASM-Henry Marion Howe medal award for a joint technical paper went to Dr. Alexander R. Troiano, head of the metallurgy department of Case Institute of Technology; Dr. William Barnett, former Case research associate now with General Electric Co.; and Dr. Richard P. Frohmberg, also a former Case research associate and now senior engineer with North American Aviation.

Du Pont Ups Output of Transparent Films

A substantial expansion of productive capacity has been announced by Du Pont for its cellophane and Mylar films. Scheduled for completion in the early part of 1958, a new construction at the Circleville, Ohio, plant will increase Mylar production by approximately 50%. Cellophane production will be increased about 10 million pounds by the middle of 1958, and another 20-million-pound increase is planned for shortly thereafter.

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SYLVANIA
WIRE
TUNGSTEN
50/50 TUNGSTEN-MOLYBDENUM
MOLYBDENUM

...when your product demands the highest standard of uniformity

BECAUSE of high metal purity plus exceptional uniformity in size and physical properties, Sylvania wire will help you hold rejection losses to a minimum . . . help you maintain consistently higher product performance standards.

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There is a Sylvania wire for every vacuum and gas tube application, in a full range of sizes down to the finest available—bare or plated with gold, rhodium, silver or nickel. Extra-long lengths can be supplied on order.

As the specifications for tube characteristics vary—so your wire requirements will vary. Next time you need standard or special wires, call in your Sylvania sales engineer. He will help you get exactly what you need, *when* you need it!

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Tungsten and Chemical Division, Towanda, Penn.

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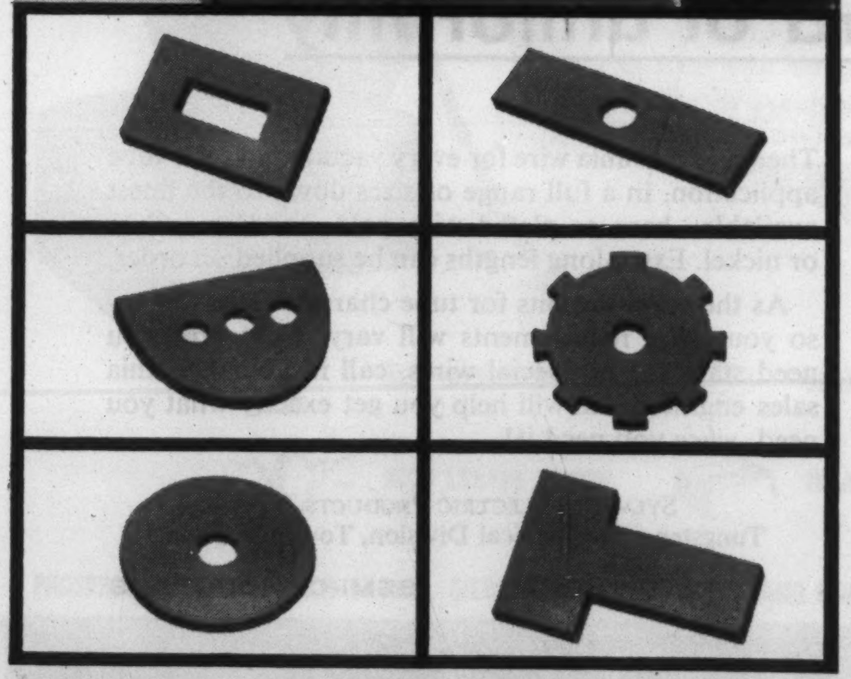

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United States Rubber

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LETTERS TO THE EDITOR

continued from p 14

Name" evokes these thoughts. Hitherto we were glad that the English expression "impact extrusion" was so clearly appropriate, as is the one used in Germany since 1942—"fliesspressen" (flow pressing).

Unfortunately you used the old expression "kaltspritzen" which was replaced in 1942 and is used today only by a few manufacturers of collapsible tubes. "Fliesspressen" is our standard expression.

Herlan & Co.
Gerwigstrasse 53/57
Karlsruhe, Germany

Thanks to our German readers for clarification on this point. Guess our technical German is a bit on the old schoolbook style.

Sulfurizing for diesel parts?

To the Editor:

Your article on "Sulfurizing" appearing in the Sept '56 issue of MATERIALS & METHODS is extremely interesting and possibly has application to parts which go into the manufacture of our diesel engines.

We would be very much interested in any other data which you might have on this process and perhaps getting a sample part sulfurized for investigation as to metallurgical properties. Is this a proprietary process or can the necessary ingredients of the salt bath be purchased for use in any plant? . . .

R. M. BAKER
Chief Metallurgist
Cleveland Diesel Engine Div.
General Motors Corp.
Cleveland, Ohio

Sulfurizing is a proprietary process and Lubri-Case, Inc. has made an initial installation at the Drever Co. in Philadelphia. Readers interested in further data or in having sample parts sulfurized should contact Carl M. Loeb, Jr., Lubri-Case, Inc., 137 E. 57 St., New York 22, N. Y.

Wanted: data on friction materials

To the Editor:

We are very much in need of up-to-date information on friction materials, particularly those operating at elevated temperatures. We suspect that there are a number of new materials of superior wear and high temperature characteristics, either on the market or about to appear on the market, but so far we have been unable to locate definite information on such materials.

Could you refer us to a source of information, or if you have information on the subject, could you supply it to us? . . .

JOHN D. NOTHSTINE, P.E.
Paramount Engineering
Livonia, Mich.

We are preparing an article on this subject, but we have not published anything recently. A paper presented by W. H. DuBois of Bendix Products before the National Tractor Meeting of the Society of Automotive Engineers in September 1956 may be helpful. American Brakeshoe Co., Johns-Manville and Armour Research Foundation are organizations that might be of help.

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News about

B.F.Goodrich Chemical ***raw materials***

PLUG VALVE *of Geon for handling corrosive fluids demonstrates molding of complicated shapes with integral threads. At the bearing surfaces Geon is molded to another plastic.*

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All parts shown made by Tube Turns Plastics, Inc.

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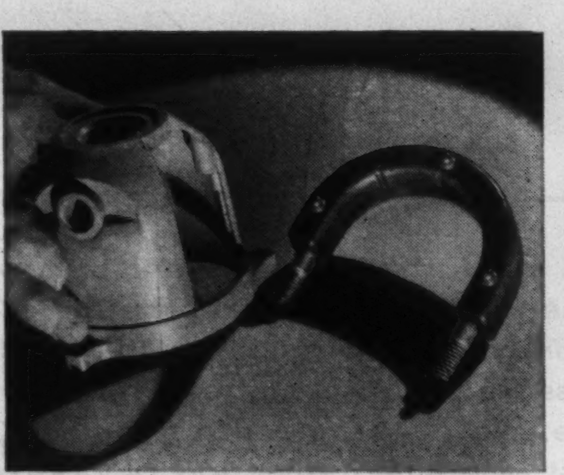
BIG FELLOWS *include piping tee and motor housing, requiring heavy cross section, chemical inertness, dimensional stability. By contrast, molding for automobile dashboard has thin section, large projected area.*



ELECTRICAL PARTS *include fractional horsepower motor housing which reduces appliance weight, and hanger band for transformer with Geon molded around metal bolt. Geon has excellent dielectric properties.*

AUTO HORN *trumpet shows complicated contours possible in rigid Geon. Note very thin walls obtained in this high-impact material. Photos courtesy Tube Turns Plastics, Inc., Louisville, Ky.*

B.F.Goodrich **GEON polyvinyl materials • HYCAR American rubber and latex • GOOD-RITE chemicals and plasticizers • HARMON colors**

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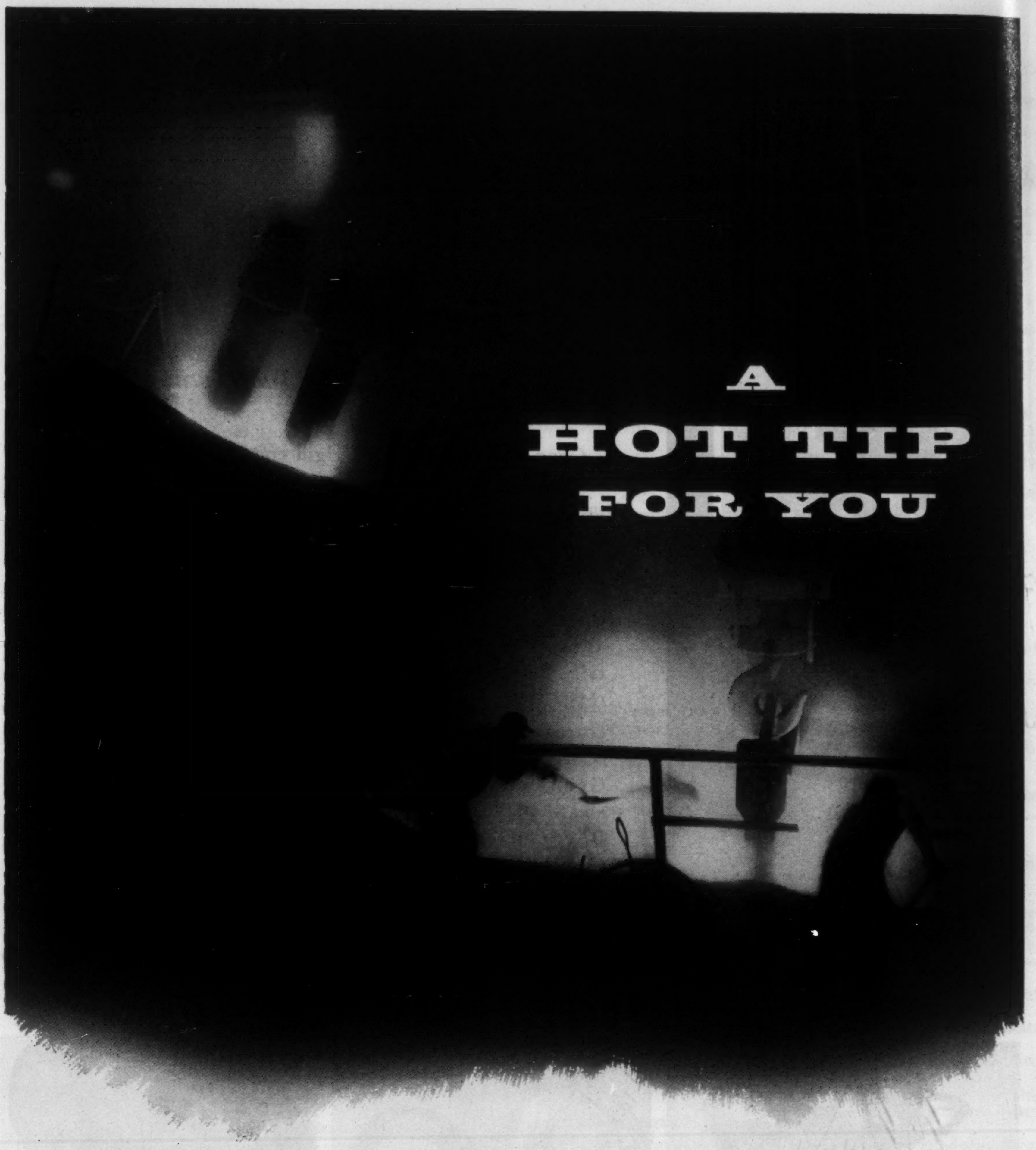

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Materials
BRIEFS

Titanium Gets Shot

Forming titanium in a die has been a problem because of springback from die edges after release of pressure. Now springback may be eliminated by firing a cartridge behind the punch.

. . . But Strikes Back

Titanium makes up from 8 to 60% of some pyrophoric compositions that have been proposed as "flints" for cigarette lighters. The new compounds have better sparking properties than presently used cerium compounds.

Free Wheeling

Lawnmower wheels of high impact polystyrene frames and spokes molded around a preformed nylon bearing are proving practical. The nylon bearing offers high abrasion resistance and low friction; the styrene frame resists bending, warping and denting.

Stepping Lightly

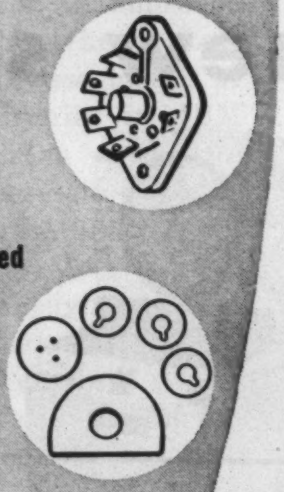
Polyethylene heel bases will be used for men's and some women's shoes. The economical base is lighter and takes a better finish than current heel bases, and it will not absorb moisture or distort.

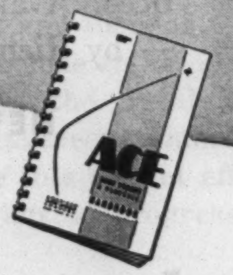
Steel Cooler

Stainless steel radiator parts are being used for the first time in some 1957 automobiles. Type 430 was selected on the basis of extensive corrosion tests, strength and workability considerations, and the need to avoid critical materials.

Aluminum "Tin" Cans

Trimming of manufacturing costs may result in aluminum cans replacing black-plated steel "tin" cans. Toilet items will appear in aerosol aluminum containers this Christmas, and a Western brewer is also considering the idea.





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- ARC RESISTANCE
- STRENGTH & WEAR RESISTANCE
- STABILITY

in molded electrical parts?

Today's new Ace Hard Rubber compounds are far more than "just good insulators" in electrical-mechanical parts. Look at these representative values: Tensile strength to 10,000 psi, moisture absorption as low as 0.04%, power factor 0.006; arc resistance as high as 190; dielectric strength to 600 v/mil; surface resistance over 10^8 megohms; heat resistance to 300 deg. F. Compounds can be blended to give just the right combination of properties for each job... economically, too, because it's never necessary to "over-design." Practically any size and shape can be molded, even with complicated inserts. Machinable to close tolerances, with excellent dimensional stability. Why not check up on today's new compounds for your designs?

ACE® dielectrics:

High dielectric sheet and extruded shapes ideal for myriads of punched or machined parts.

Design hints covering wide variety of Ace hard rubber, Ace plastics, and rubber-plastic blends are available in 80-pg. Ace Handbook. Write for your copy today.

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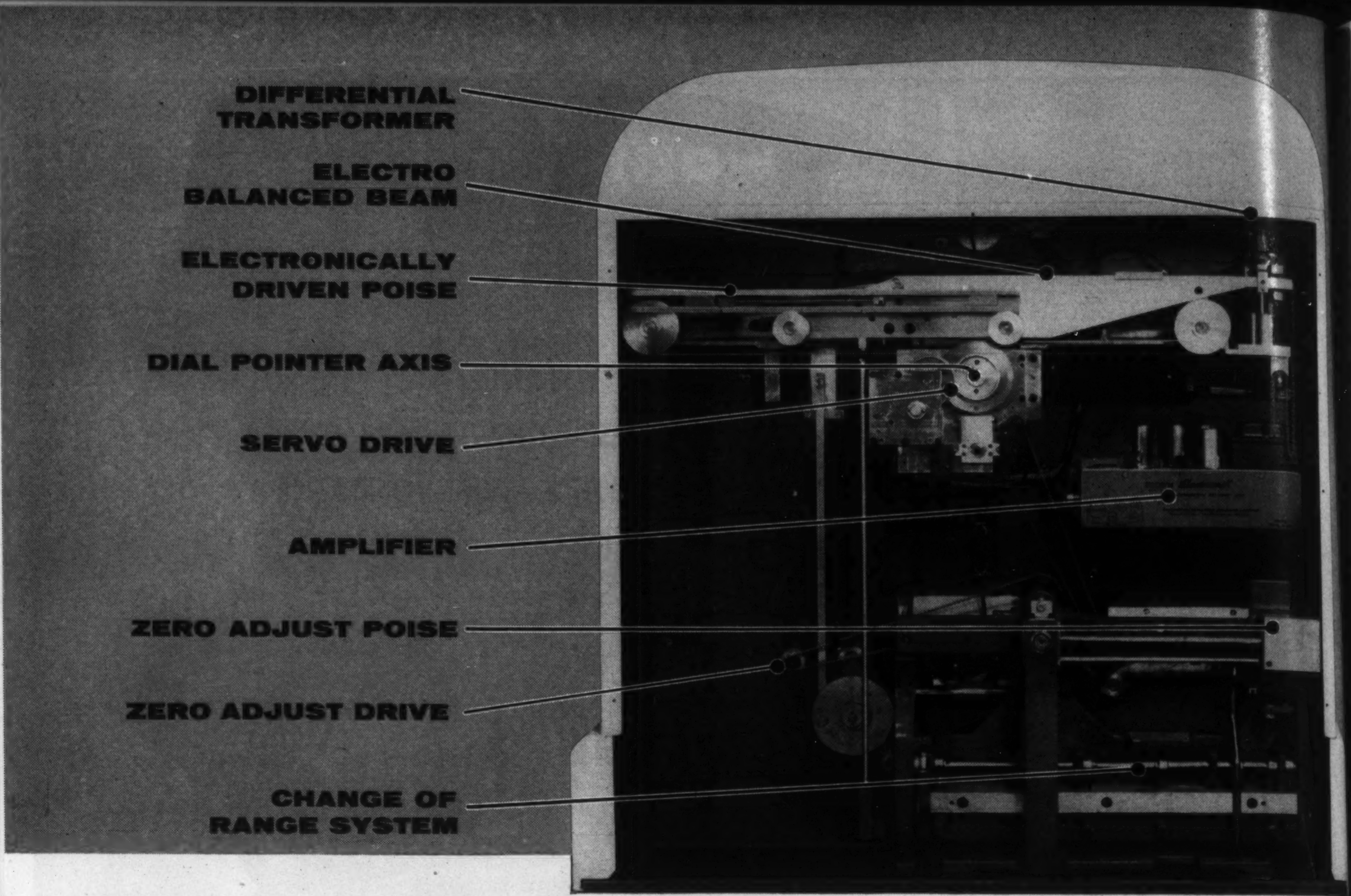
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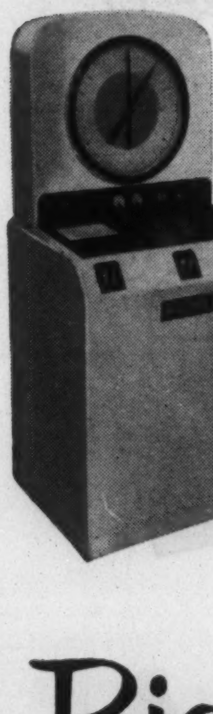
ON THIS LATEST RIEHLE INDICATING UNIT



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COMPANY

ADDRESS

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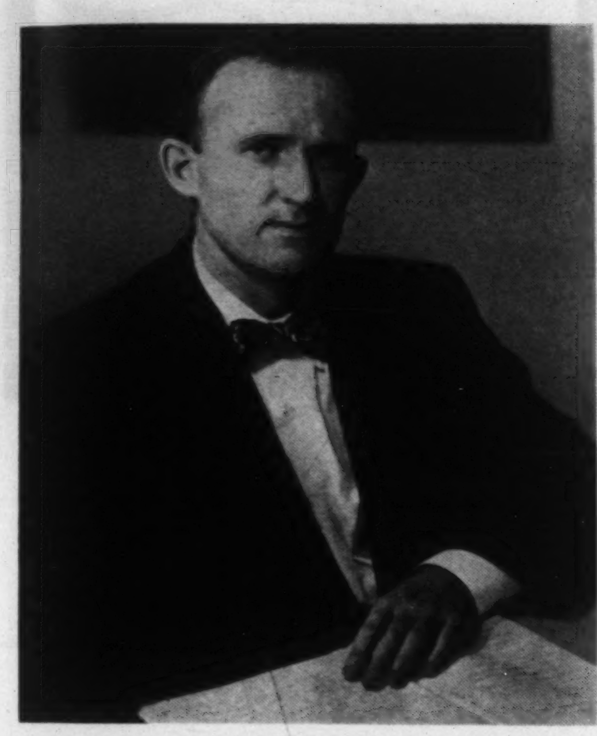
ATTENTION MR.

Men of Materials...

Polleys says:

"The designer must have engineering data on a broader range of materials."



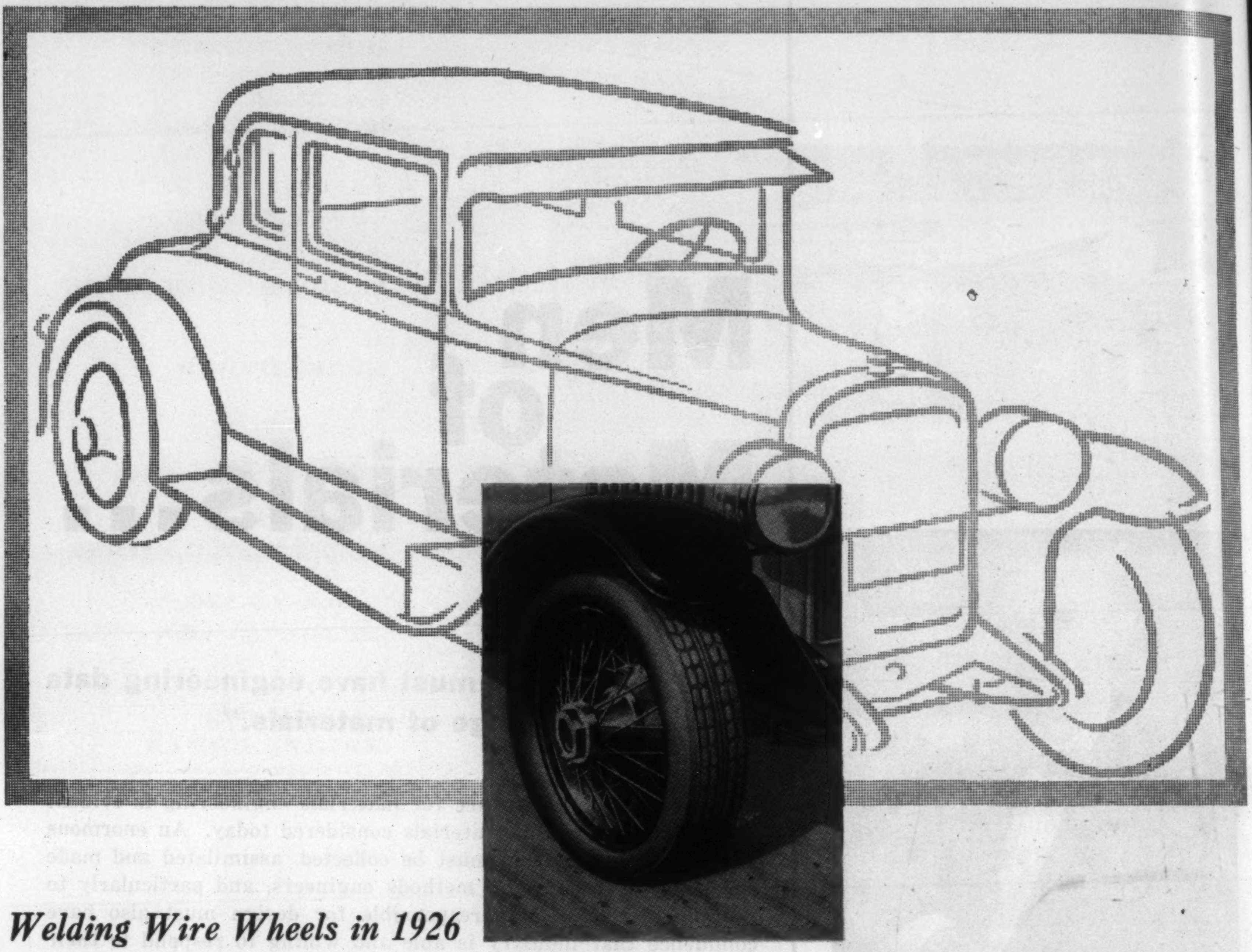
R. W. Polleys, formerly organic finishing engineer and plant chemical engineer of General Electric Co., is now chemical engineer for materials and finishes with International Business Machines Corp. and technical services manager of the Product Development Lab. in Poughkeepsie, N. Y. A chemical engineering graduate of Yale University, Mr. Polleys is a member of American Society for Testing Materials, American Society for Metals, American Electroplaters Society and American Chemical Society.

"The challenging future for materials engineering is evident in the broad range of materials considered today. An enormous amount of information must be collected, assimilated and made available to process and methods engineers, and particularly to design engineers. Men responsible for design must also have confidence that industry is able and willing to respond to their needs.

"Materials requirements have undergone tremendous changes in the past few years. The use of vinyl-clad steel for IBM machine covers is one example: the need for an improved decorative and wear resistant coating was met by a heavy, textured vinyl film bonded to a formable, structural base metal. A more recent change is the use of printed circuits in IBM machines to reduce manufacturing costs and design space consumption. Another is the use of alloy coatings possessing specific magnetic properties to produce magnetic information storage drums.

"A further look at areas in which the design engineer must feel at home will point up the problem. There is the wide application of plastics for laminates, foams, casting resins, adhesives and coatings. Glass is becoming increasingly useful. Magnetic materials of high permeability, rare earths, powders, ceramics and ferrites are much in demand.

"Learning to use the concepts and tools of materials engineering is not something that can be done in an offhand manner. More consideration must be given to the training, formal and informal, of materials and process engineers. Industry, technical societies and universities must make this a joint effort to ensure aggressive design engineering, the key to progress."



Welding Wire Wheels in 1926

Helped MALLORY Learn Better Ways to Solve Your Welding Problems Today

THIRTY YEARS AGO, a leading auto manufacturer (still a leader today) ran into a serious production bottleneck in resistance welding of wire wheels. The copper dies being used wore out so quickly that costs were too high, production too slow.

Elkonite®, a material developed by Mallory, looked promising for this application. It was tried . . . and the results were excellent. Die life increased tenfold. And production was freed of stoppage troubles.

This development marked Mallory's entry into the resistance welding field. It has been followed, in succeeding years, by a continuous stream of contributions to welding technology. These are some of the major milestones in Mallory progress:

Specialized alloys, like Elkaloy® A, Mallory 3, Mallory 22 and many others, which provide a family of materials engineered for the specific needs of welding service.

Fluted electrodes, which greatly increase electrode life.

Cold forming methods for producing bent electrodes with greater hardness and strength.

Special holder designs to meet the needs for higher pressures for large welding machines, and low pressures for non-ferrous alloys.

The knowledge gained during three decades of pioneering activity and constant development stands ready to serve on your own resistance welding problems. Write or call Mallory for a personal consultation by a Mallory welding engineer . . and see your local Mallory welding distributor for prompt delivery of the best in welding electrodes, holders, seam welding wheels, forgings and supplies.

In Canada, made and sold by Johnson Matthey & Mallory, Ltd., 110 Industry Street, Toronto 15, Ontario.

For information on titanium developments, contact Mallory-Sharon Titanium Corp., Niles, Ohio.

30 Years of Welding Progress

P. R. MALLORY & CO. Inc.

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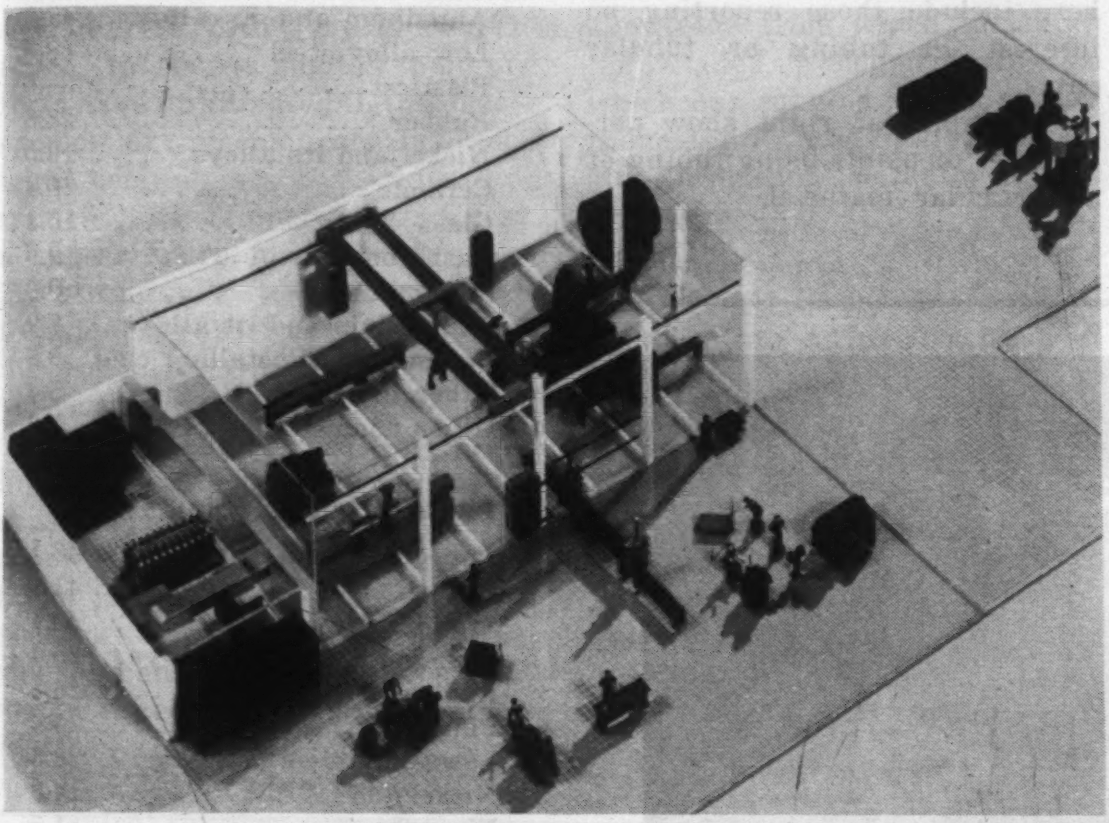
MATERIALS ENGINEERING NEWS

This month

- *Working under inert gas*
- *'Printed' holes and shapes*
- *High temperature materials*



***Model of molybdenum fabrication room** in which alloys of the metal will be formed under inert gas atmosphere and high temperature. Vacuum arc furnace is on the extreme right.*

Molybdenum To Be Fabricated in Inert Gas Atmosphere

Molybdenum and other refractory metals will be fabricated in a completely enclosed room under an inert gas atmosphere and at temperatures ranging from 3500 to 4000 F in a new pilot plant being built by Universal Cyclops Steel Corp. Known as In-Fab, the project is part of this company's research and development work at Bridgeville, Pa.

Oxidation has presented problems in trying to fabricate molybdenum-base alloys with conventional steel mill equipment or at conventional temperatures. The new pilot plant room has been designed to heat, forge and roll molybdenum ingots in an inert atmosphere. The room will have three air locks: one for equipment, one for supplies and one for personnel.

The ingots will be made by sintering and fusing together molybdenum powder into a column under vacuum. This column will be arc cast into an ingot in a vacuum arc furnace in a corner of the same building.

Universal-Cyclops is now constructing the pilot plant in conjunction with the Navy Bureau of Aeronautics and has hopes of the project being in operation by the end of 1957.

Large Aluminum Ingots Successfully Cast

A process has been developed for successfully casting large aluminum ingots up to 32 in. in dia. Use of the larger ingots increases the size and improves the quality of forged and extruded parts and will allow more efficient use of the Air Force's heavy press program.

The process resulted from a manufacturing methods development contract awarded Kaiser Aluminum and Chemical Corp. by the Air Materiel Command. Purpose of the program was to investigate and develop optimum manufacturing procedures for preparation and production of sound, high strength aluminum alloy ingots, forging stock and forgings.

All of the experimental large ingots were found to be sound ultrasonically. In other aspects, such as macrostructure, microstructure and grain size, they resembled smaller size ingots commercially available. There was very little difference in grain size with increasing ingot size. Tests showed that 7075 alloy forgings with superior transverse elongation and impact strength were produced from materials made from the large ingots as compared with forgings made from commercial materials. The quality of the forgings made from the large ingots was found to be more related to the quality of the parent ingot than to the method of stock preparation.

M & M Survey of Pipe and Tubing

Study shows materials and types most widely used

■ Carbon and stainless steel are the most widely used for mechanical applications, and copper and copper alloy tubing are the most widely used for carrying fluids, a recent survey indicates. Seamless tubing is used in two-thirds or more of plants making hard goods and original equipment.

These conclusions are based on the results of a MATERIALS & METHODS survey of markets for tubing, pipe, and tubular parts. Questionnaires mailed to 1000 subscribers got a response of 52.8%, and the figures tabulated here include those reporting no interest in tubing or tubular parts.

The tables at right show percentages of plants using tubing of a particular material.

Tubing Materials

Structural Tubing	
Carbon steel	67.3
Stainless steel	54.6
Copper and its alloys	48.5
Aluminum and its alloys	47.7
Low alloy steel	38.3
Plastics	34.6
Rubber	28.8
Nickel and its alloys	18.5
Ceramic	10.4
Glass	10.4
Cast iron	9.6
Wrought iron	9.0
Magnesium and its alloys	7.9
Composite, bimetallic, clad	6.5
Other metals	5.4
Other nonmetallics	4.2

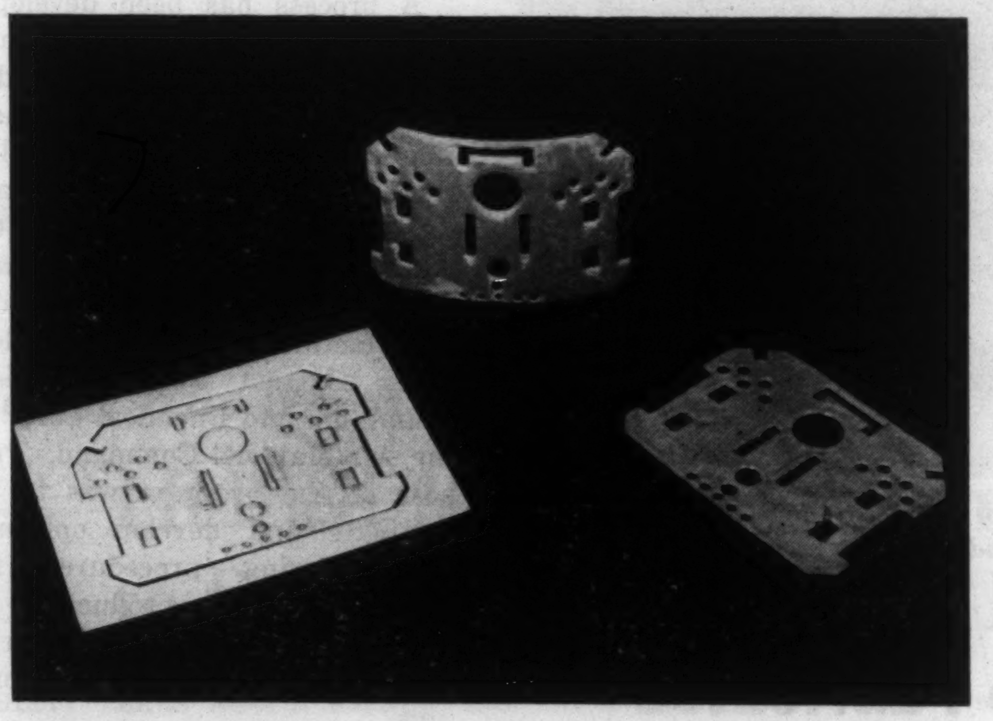
Fluid-Carrying Tubing	
Copper and its alloys	48.1
Carbon steel	41.7
Stainless steel	40.4
Aluminum and its alloys	29.4
Rubber	26.5
Plastics	25.4
Low alloy steel	23.3
Nickel and its alloys	14.8
Wrought iron	11.5
Cast iron	7.7
Glass	6.9
Composite, bimetallic, clad	4.0
Magnesium and its alloys	3.3
Ceramic	3.1
Other metals	2.7
Other nonmetallics	1.9

The types of mechanical and fluid-carrying tubing show the following degree of use:

Mechanical — seamless (hot or cold formed), 77.7%; welded, 44.2; extruded, 42.7; molded, 22.5; cast, 15.4; other, 10.6.

Fluid-carrying — seamless (hot or cold formed) 66.0%; welded, 29.6; extruded, 26.9; molded, 12.3; cast, 8.1; other, 4.0.

One of the purposes of this and similar surveys conducted by MATERIALS & METHODS is to learn the major interests of M&M readers so that the most suitable editorial program can be planned.



***Holes are 'printed'** in epoxies, polyesters and other plastics by using conventional letterpress and deeply etched plate. Parts can be flat or curved; these parts measure 3 by 4 by 1/16.*

Printed Holes and Shapes

By mounting a deeply etched printing plate into a conventional letterpress, Plastics & Electronics Corp. has developed an inexpensive, simple method of producing holes and shapes in plastics materials before curing.

In operation, inking rolls are removed from the press, and partially cured, or thixotropic, resin is applied to a carrier sheet in a smooth layer of desired thickness. The assembly is then placed on the platen and the press closed. Upon opening, the printing plate leaves an impression of the hole design through the resin. After the plastics material is cured, the center cores of the formed holes and the flash around the formed edges are removed by air blasts or tumbling.

Plastics currently adaptable to the new process include epoxies, polyesters and plastisols. Fillers and pigments can be added. Possible applications include printed circuit bases, terminal panels, nameplates, grillework, and reinforced plastics parts and gears.

GE puts heat on ceramics, titanium

New Materials Used for Hot Components

For years General Electric Co. has been attacking the problem of pushing back the thermal barrier encountered with supersonic flight. In recent months their efforts have culminated in the development of mechanical and electrical components that resist extremely high temperatures. These advances were made by developing stronger materials and better techniques, rather than by improving protective equipment.

Ernest E. Johnson, general manager of the General Engineering Laboratory in Schenectady, says "these major jumps in environmental conditions called for major jumps in components' tolerance to—or ability to live in—the environment. The equipment or material required to protect them is often too heavy or just plain not capable of doing the job."

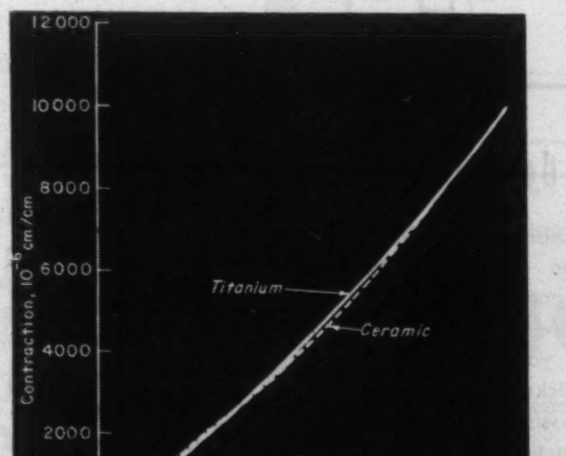
A typical problem: Dr. A. G. Pincus, GE scientist who developed the special Forsterite ceramic used in several of the new components, had to develop a material that was chemically stable, mechanically strong, a good electrical insulator at the operating temperature, vacuum tight, and similar to titanium in its expansion characteristics over a wide temperature range (see accompanying graph). He had available to him a knowledge of how solids deform under stress at different temperatures and of how they conduct electricity. This indicated that glass would not be acceptable and that only a crystalline ceramic could be used. He knew that by suitably adjusting the composition he might be able to control the identity of the crystalline phases which make up the body and thus control the coefficient of expansion. Finally, there was scientific information on the mechanism by which powdered ceramic raw materials sinter during firing to form a solid, nonporous, vacuum-tight body. He thus had a platform of knowledge from which to launch the detailed development program which has culminated in some of the materials used in high temperature, radiation-tolerant electronic components.

The components

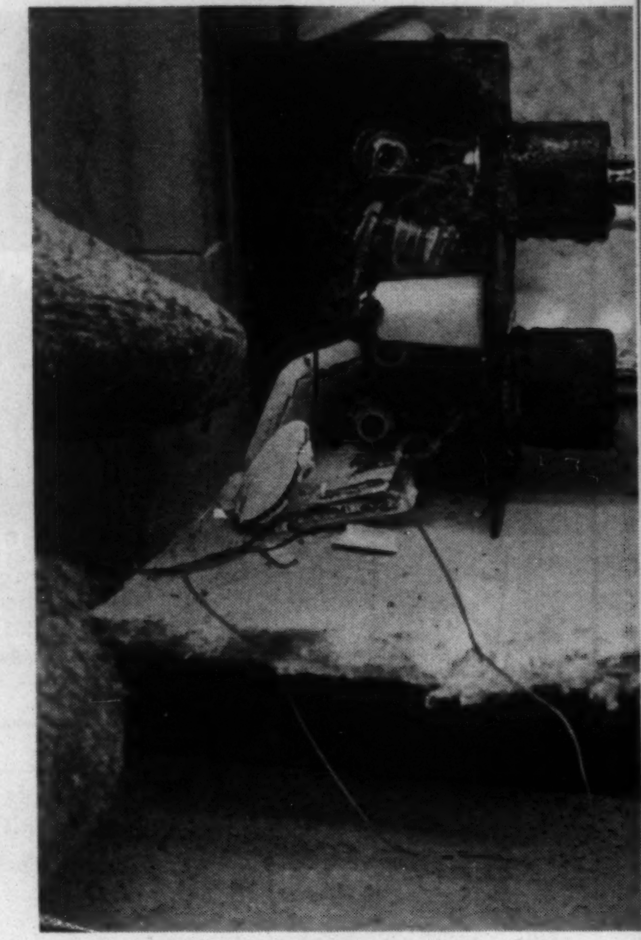
Resistors—Resistors capable of operation to 1470 F consist of hollow ceramic tubes with internal surfaces covered with a resistive coating. The tube is sealed under vacuum by titanium caps which make electrical connections with the two ends of the resistive film. Recent work in the research laboratory has developed newer surface films capable of producing resistors with values up to several megohms at 1100 F.

Capacitors — Considerations involved in the search for materials for capacitors provide an excellent picture of GE's approach to materials selection problems. Initial studies of materials suitable as high temperature dielectrics showed that many conventional

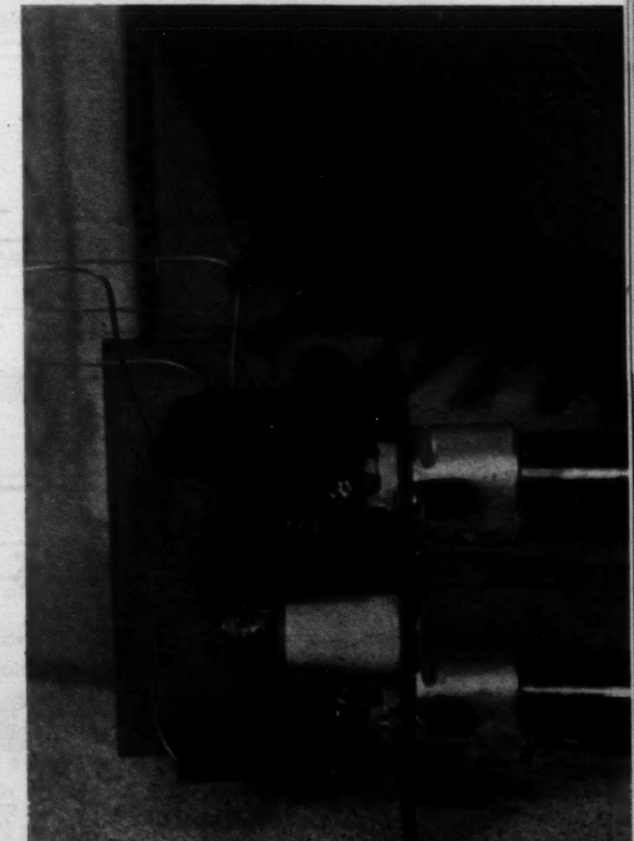
(continued on p 216)



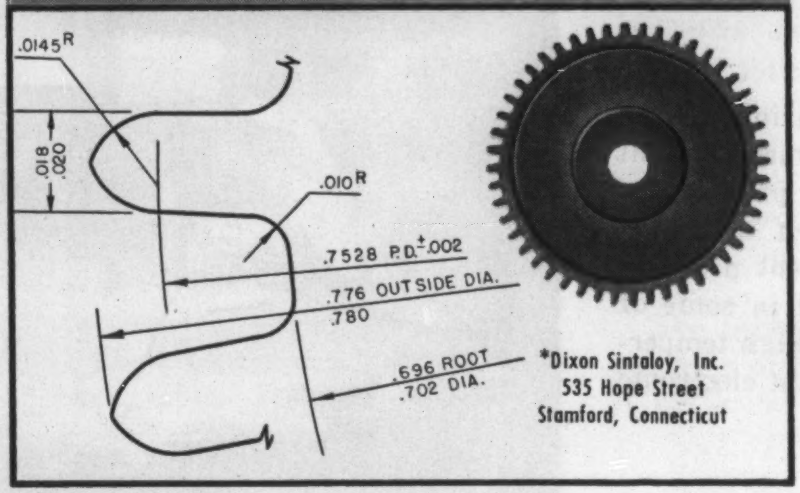
Linear contraction *characteristics compared for titanium and a special new ceramic.*



Old and new circuits *after exposure to 1500 F. Ordinary electronic circuit is shown above. Circuit below, utilizing new materials developed by General Electric, has operated for thousands of hours at this same temperature.*



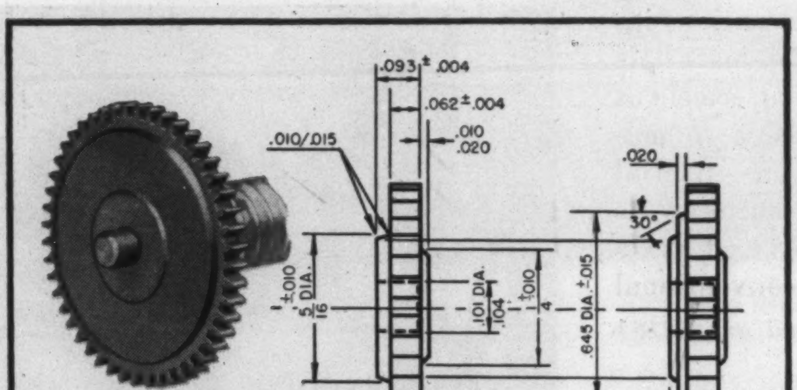
BRASS GEARS
PRESSED FROM POWDER



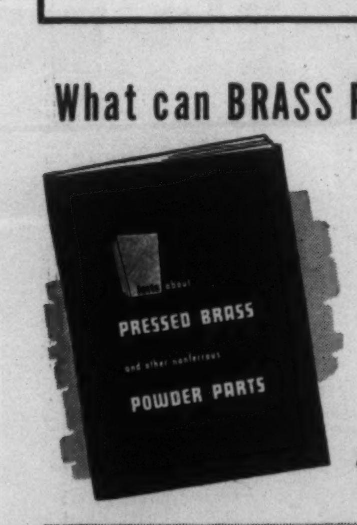
. . . not only save money in manufacturing costs at the Marvel-Schebler Products Division of the Borg-Warner Corporation, but they are made dimensionally accurate to very close tolerances by its supplier* of brass powder parts.

Alternative methods of production involve scrap loss, machining time and expensive bar stock. On the other hand, as pressed and sintered from 80–20 leaded brass, the gear requires no secondary operations, involves no scrap loss, is accurate and durable.

The linear sequential timer in which this brass powder gear is used controls the operations of a leading home appliance in which dependability, long life and low cost are of major importance.



What can BRASS POWDER PARTS do for you?



For detailed information on the design, properties, production and application of brass and other nonferrous powder parts you should have a copy of our manual. It will give you 20 case histories of brass and nickel silver powder structural parts to assist in evaluating this means of production in terms of your particular needs.

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THE NEW JERSEY ZINC COMPANY
160 Front Street, New York 38, N. Y.

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For more information, turn to Reader Service Card, Circle No. 529

LETTERS TO THE EDITOR

Yes, we'll have a 'handbook'

To the Editor:

I would like to repeat what I've said before—M&M is an excellent magazine. But I would appreciate your comment on the following: Would it be possible for M&M to issue a yearly handbook of materials engineering information? Even at some increased cost to the subscriber it would be highly desirable.

At present I dissect my copy of M&M, by removing the clips, in order to file selected articles and all the Engineering File Facts. To say the least, this is a very inconvenient and time consuming operation, plus the fact that loose pages will not stay in order.

W. A. Meissner
Tele-Dynamics, Inc.
Merchantville, N. J.

We appreciate these comments and would like to take this occasion to make the first editorial announcement of the 1957 Materials Selector for Product Design. The "Selector" will include two major sections: a Selection Guide that provides extensive property data approached from several angles, and a Buying Guide that is an alphabetical listing of materials, parts and forms with names and addresses of suppliers. This "handbook" will be included as part of the regular subscription (in addition to our 12 regular issues) at no increase in price. See "Last Word", p 278 for further details.

Readers in mid-air

To the Editor:

Just what is the purpose of the "Materials Outlook" feature in your magazine?

It seems to me that the reader is left in mid-air. If reference is being made to some article in the magazine, then why not give a page index? . . .

T. A. Saulnier
Radio Corp. of America
Lancaster, Pa.

We are giving Mr. Saulnier's suggestion, and the suggestions of others, careful thought. For the record, we would like to point out that "Materials Outlook" is not a summary of material appearing elsewhere in the issue. In many cases we cannot give references without betraying confidences or listing a great many sources. However, readers who inquire of our Reader Service Dept. by letter or by phone will get prompt service and the personal attention of the editors where necessary.

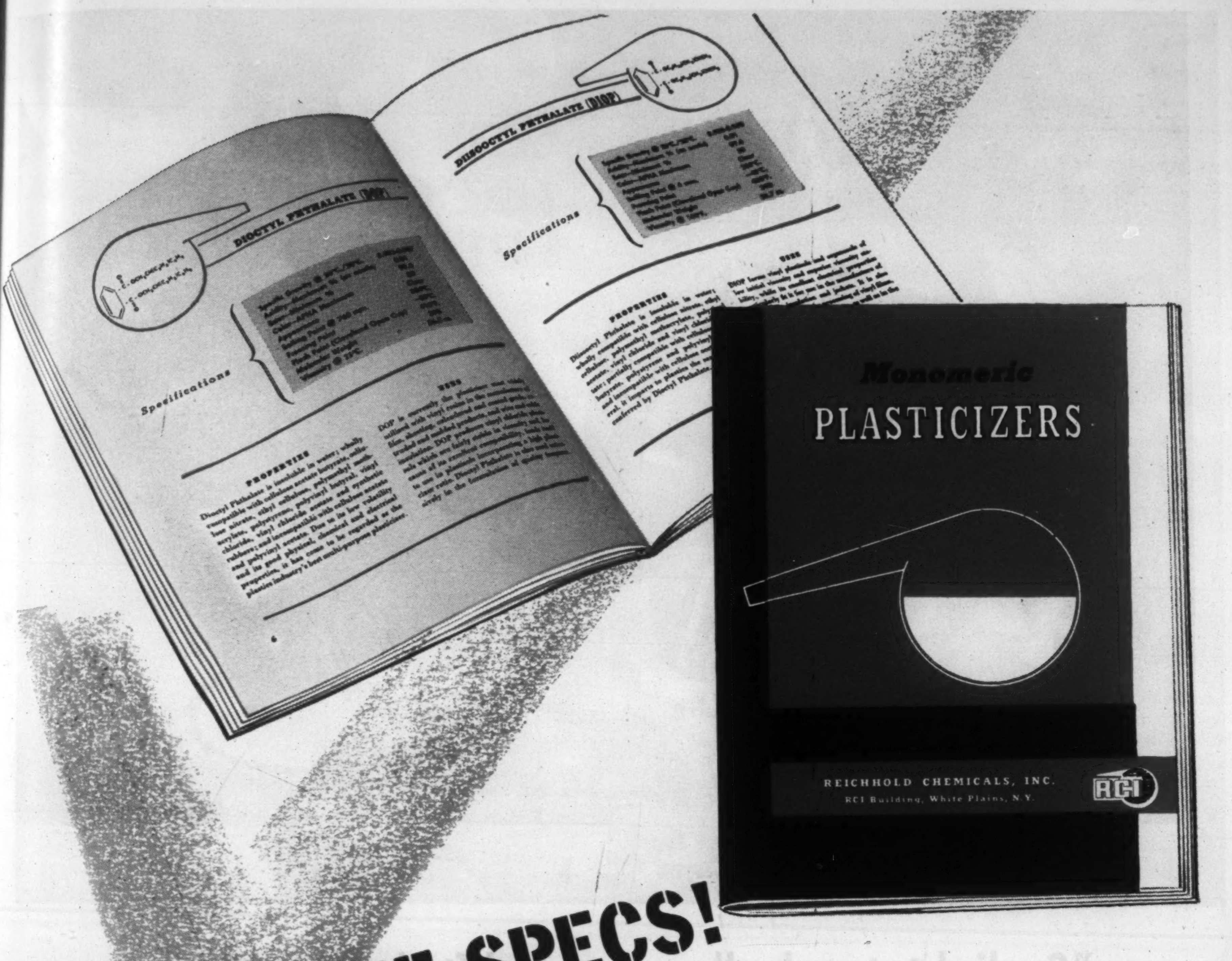
A rose is a rose

To the Editor:

In reference to "Impact (Cold) Extruded Parts" published in Materials & Methods, Aug '55, we would like you to know we read the article, which all experts considered excellent, with great interest.

The boxed information entited "Needed: A

(continued on p 242)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Because impurities responsible for inferior end products have been removed, these RCI materials feature a high degree of plasticizing efficiency. Your own laboratory and plant tests will demonstrate that RCI plasticizers are not only unusually stable, but also display a pronounced resistance to detergent extraction.

Write for the catalog on RCI Monomeric Plasticizers illustrated above. Attach the coupon at right to your letterhead. When you've read the catalog, send for a free sample of any plasticizer you want to test after studying the specifications. Included in this RCI line are:

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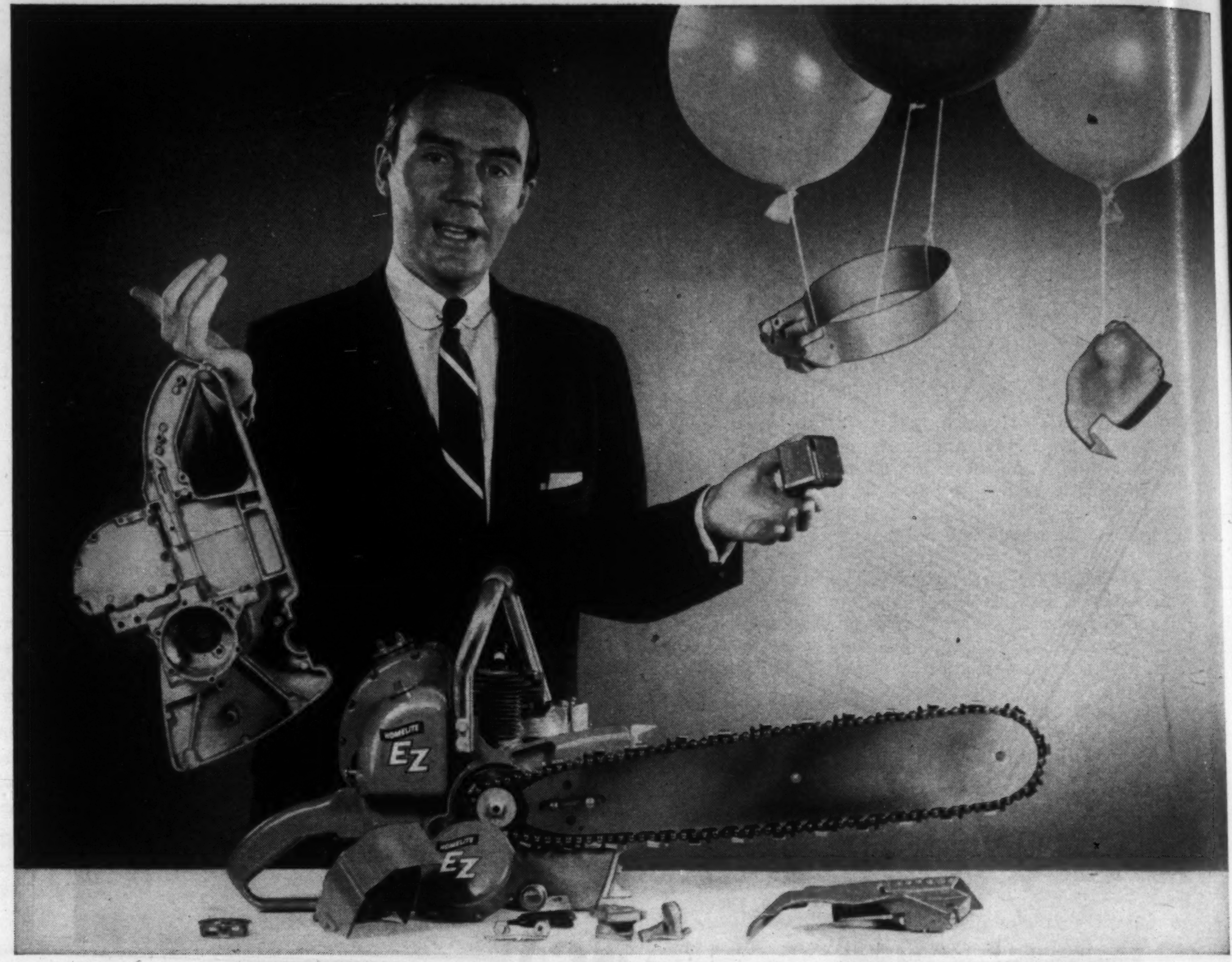
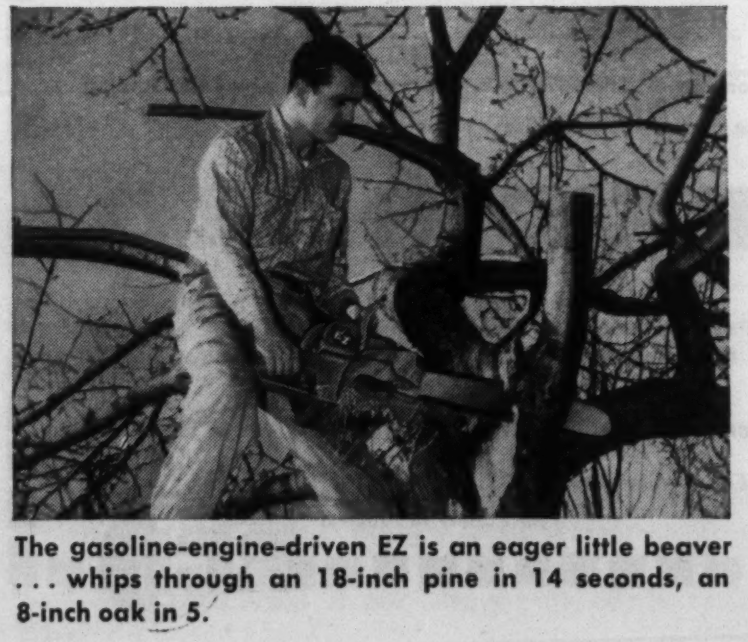


"So light, toy balloons can lift them..."

Bantam-weight Doehler-Jarvis Homelite pack 5 horsepower


The gasoline-engine-driven EZ is an eager little beaver . . . whips through an 18-inch pine in 14 seconds, an 8-inch oak in 5.

This just shows that magnesium die castings are the lightest of light.

And they are amazingly strong.

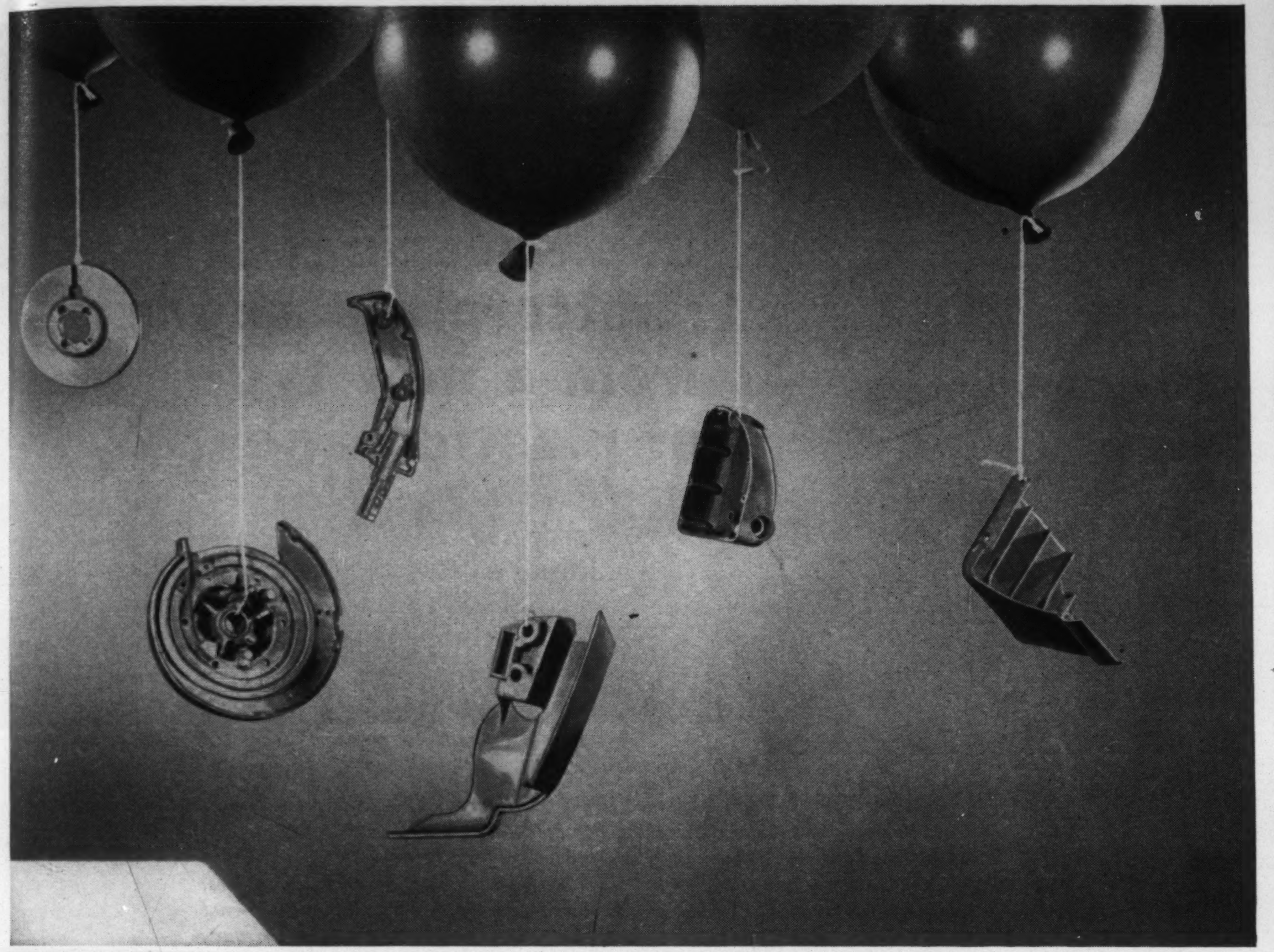
With these particular Doehler-Jarvis magnesium die-castings, for example, Homelite (division of Textron Inc.) packs 5 horsepower into their heavy-duty EZ direct drive chain saw and still keeps weight down to 19 pounds.

Design aids lightness, too

This sales-building lightness and strength is not based solely on the use of magnesium. Homelite and Doehler-Jarvis engineers also eliminate practically all excess metal. They do this by taking advantage of minimum thickness die-cast sections. Ribs provide rigidity.

They do away with much machining, too. And cast in several competitive advantages. For example:

- Die casting establishes accurate machining base points. These permit multi-jig production and both improve



magnesium die castings help into this 19-pound chain saw

dimensional accuracy and reduce cost.

- Servicing instructions in bas-relief are die-cast right into certain parts.

What's more, Doehler-Jarvis delivers the raw parts with near perfect "as cast" surfaces... surfaces that need only degreasing to accept a high-quality finish.

PA reports outstanding service

EZ sales got off the ground fast. Within weeks Homelite needed twice the projected quantity of castings. With a separate plant at Batavia, N. Y. for producing magnesium die castings, Doehler-Jarvis was able to respond quickly. Says Homelite's Purchasing Agent, "Those fellows out in Batavia have certainly done an outstanding job for us."

And you can be sure that Doehler-Jarvis *does* do outstanding work. Right now we're operating some 20,000 dies for some 1400 firms. Call us in on *your* next job.

Doehler-Jarvis
DIVISION OF NATIONAL LEAD COMPANY
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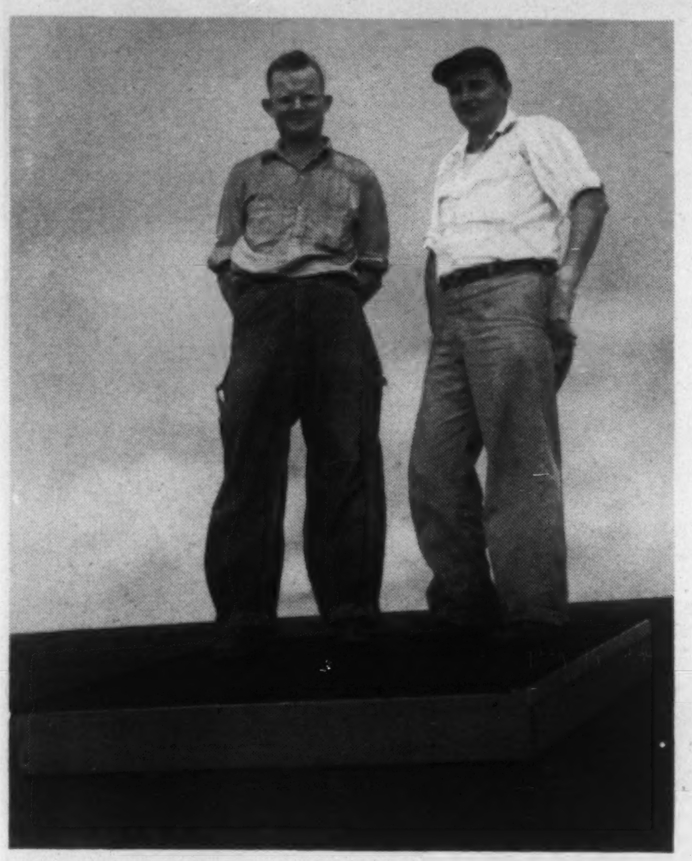
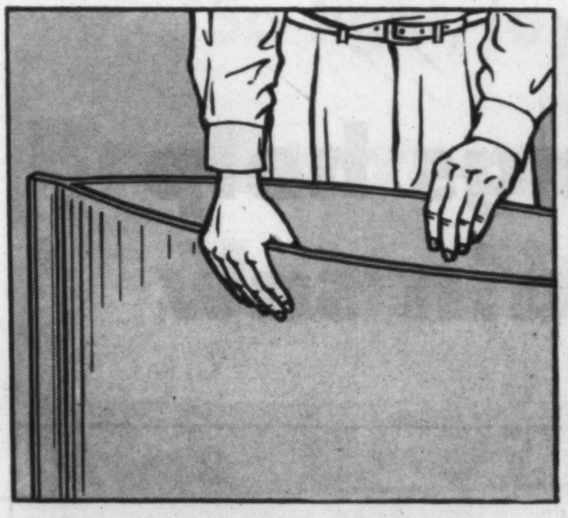
idea page | *New lift for your products, new products for your markets*



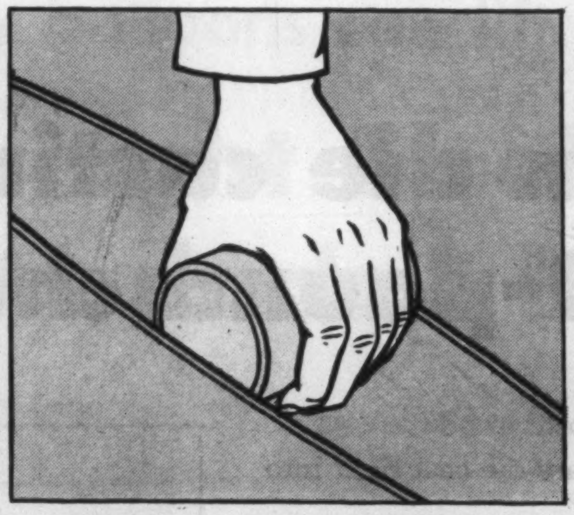
Load-bearing, shatterproof skylights from a new type of plastic panel

Special translucent panels of reinforced plastic can develop enormous load-bearing strength simply by expanding a pocket in a specially laminated "air" sandwich. Here's a new source of product ideas for your exploration and profit. For example, one manufacturer makes shatterproof skylights as large as 4′ x 10′ and strong enough to support over 400 lbs. center load.

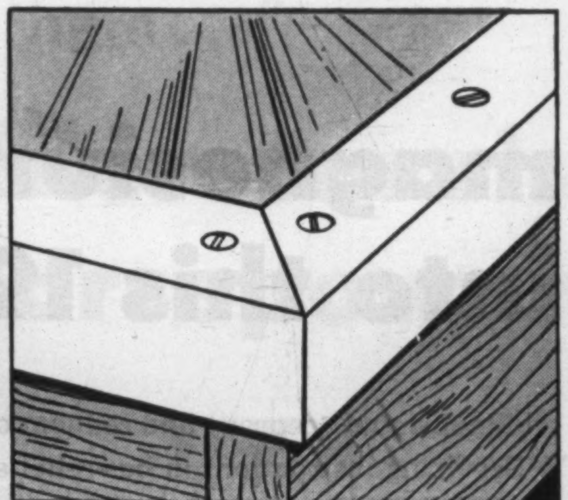
Other Design Possibilities: *High-strength expandable panels can serve as swivel-type room dividers, overhead garage doors, louvered walls. Cut smaller, they can be used for jalousies and vane-type covers for exhaust vents. The expanded sandwich transmits soft, diffused light; is available in a choice of soft colors. The high-strength, laminated "air sandwich" panels are "true laminates"—not two sheets bonded at the edge. They are weather-resistant, chemical-resistant, and shatterproof.*



Specially pocketed sheets measuring up to 4′ x 10′ are cut to size . . .



Depending on size, the sandwich is expanded with plastic tubing set on edge within the pocket.



The pocket edge is framed to size with an aluminum angle for standard installation.

Monsanto manufactures phthalic and maleic anhydrides and styrene monomer—basic ingredients in polyester resins—used in the finished materials of construction. Monsanto will be glad to send you on request the sources for made-to-order reinforced plastics skylights or expandable "sandwich" panels for construction or product engineering use. Organic Chemicals Division, MONSANTO CHEMICAL COMPANY, Dept. ID-6, St. Louis 1, Mo.

Where Creative Chemistry Works Wonders For You

MONSANTO ®

For more information, turn to Reader Service Card, Circle No. 565

Fence made from bethanized wire stays strong and bright

Much of the chain-link fencing is made today from bethanized wire — and for good reasons. The uniform coating of 99-pct-pure zinc protects the wire against corrosion long after other types of fence have become unsightly or rusted away. Bethanized fence keeps its sparkle through years of service because of the tight bond of pure zinc on steel. Fence erectors like bethanized fence because the wires are not rough and won't slash fingers.

Pure zinc, tightly bonded to steel . . . that's bethanized wire

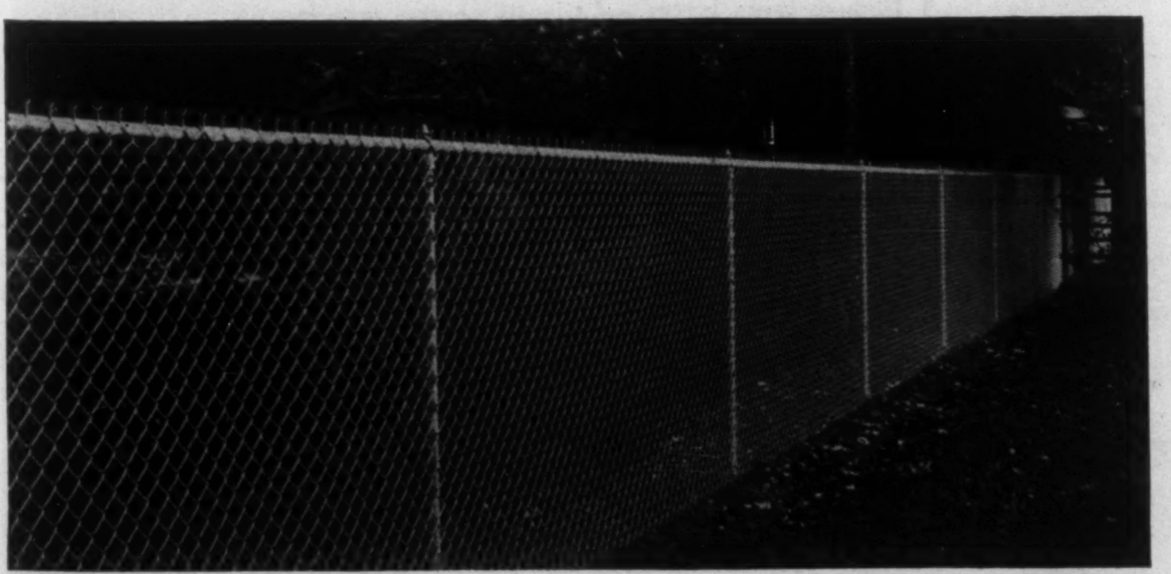
There are no thin spots in the bethanized zinc armor to give rust a foothold. The electrolytic process deposits a coating that is uniform over every inch of the wire.

Bethanized wire is ideal for twisted wire brushes, chain, conveyor belts and other products which require severe forming, swaging, cold-heading, and thread-rolling. You can bend it, twist it around its own diameter — even draw it through dies to fine gage. The pure zinc stays on.

Whether you need hard or soft-temper wire, light or heavy zinc coatings, we will be glad to ship you a trial order of bethanized. Just phone or write our nearest sales office for full details.

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

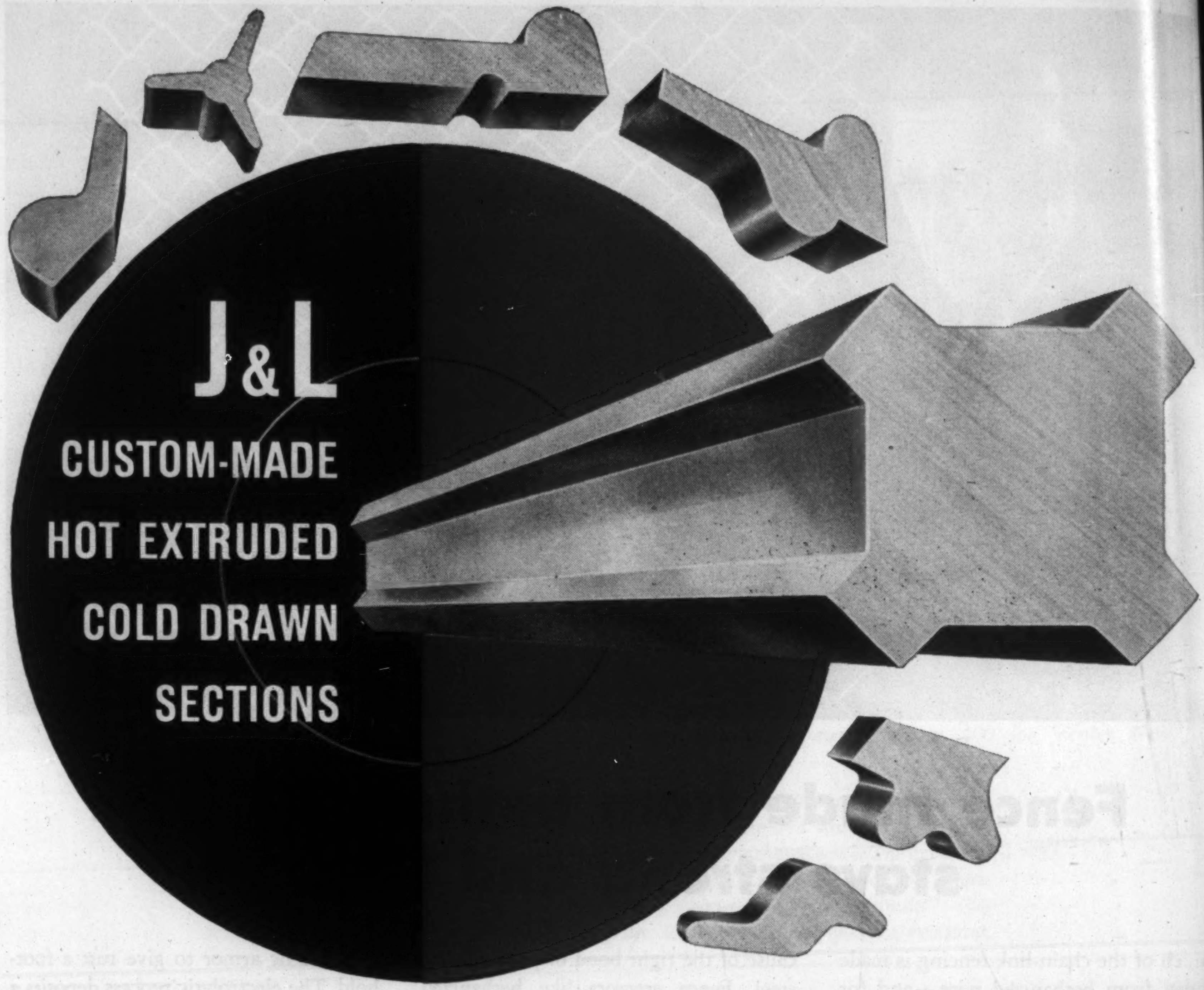


The bethanized coating of pure zinc adds extra years of service to chain-link fence. Photo courtesy: Atlas Fence Co., Philadelphia, Pa. ▲

BETHLEHEM STEEL

BETHLEHEM STEEL

For more information, turn to Reader Service Card, Circle No. 408



...boost production, cut over-all costs

WRITE TODAY for your copy of this free new booklet which gives detailed information about the many money- and time-saving advantages J&L Extruded Sections offer you.

Jones & Laughlin Steel Corporation
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Please send me your new Booklet on Extruded Sections.

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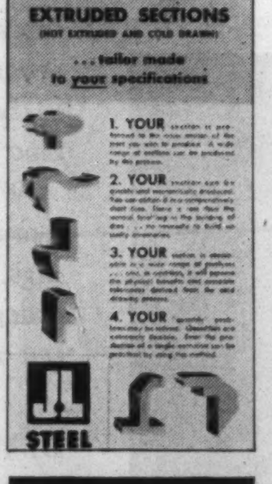

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J&L
EXTRUDED SECTIONS
(HOT EXTRUDED AND COLD DRAWN)
...tailor made
to your specifications

1. YOUR

2. YOUR

3. YOUR

4. YOUR

J&L STEEL

Progressive industry is today utilizing J&L's Custom-Made, Hot Extruded Cold Drawn Steel Sections to:

1. **Eliminate time and costs** in machining and finishing operations
2. **Reduce scrap losses** practically to the zero point
3. **Eliminate the cost of castings and forgings** of intricate sections requiring considerable machining
4. **Reduce inventories** due to quick availability of extruded sections from the J&L plant

These sections can be extruded and cold drawn to the exact specifications of the parts you require—in any quantity you specify. Even the production of a single extrusion can be economical. Obtainable in a wide range of material grades, J&L Extruded Sections can be produced in a large variety of shape profiles—within limits of a design which can be inscribed within a two-inch circle. Many shapes that cannot be hot rolled are practical for the extrusion process.

The mechanical properties of J&L Extruded Sections are equal to or superior to those obtainable from equivalent grades conventionally cold drawn. Cold drawn tolerances are accurately maintained. The excellent surfaces of these Extruded Sections require little—if any—finishing operations.

Send us your inquiry for prompt and efficient J&L service.

J&L STEEL

Jones & Laughlin
STEEL CORPORATION · PITTSBURGH

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For more information, Circle No. 383 ➤

Insulation:
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A 60-SECOND GUIDE
TO BETTER PRODUCT PERFORMANCE

SUPRAMICA® ceramoplastics

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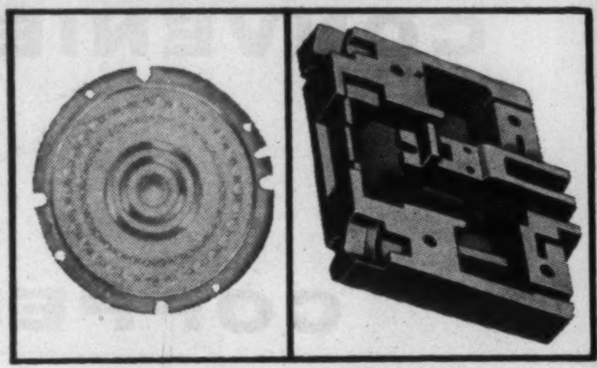
earch and production skill of MY- CORPORATION OF AMERICA has ny years given design engineers mate in versatile electrical insula- aterials . . . MYCALEX*, the *origi-* ss-bonded mica . . . SYNTHAMICA, the *first* commercially produced synthetic mica . . . and a completely new ceramoplastic — SUPRAMICA* — for applications that demand the ideal combination of physical, thermal and electrical characteristics.

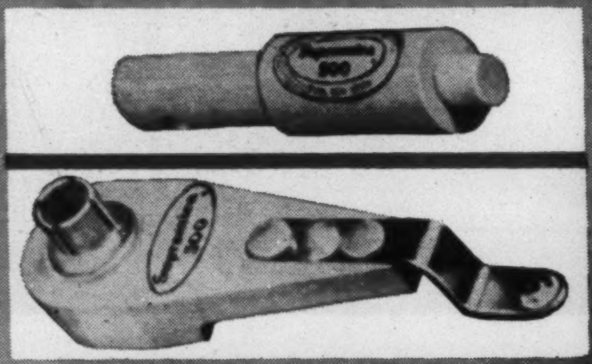
TYPICAL APPLICATIONS



SUPRAMICA® 555 is moldable!

uperior ceramoplastic insulation es . . . operation at temperatures 950°F . . . *complete* dimensional ity . . . moldable to precision toler- . . . *positive* bonding to metal in- . . low electrical loss . . . very high arc resistance . . . carbonization . . . resistance to moisture, oil and organic solvents . . . permanent radiation resistance . . . high dielectric strength . . . thermal expansion coefficient same as steel.

TYPICAL APPLICATIONS



SUPRAMICA® 500 is machineable!

superior ceramoplastic insulation es . . . operation at temperatures gh as 1000°F . . . machineable to ion tolerances . . . *absolute* di- onal stability . . . high dielectric gth . . . low electrical loss . . . very high arc resistance . . . no carbonization . . . thermal expansion matching steel . . . water-, organic solvent-, and oil-proof performance . . . permanent radiation resistance . . . good mechanical strength.

ther Famous MYCALEX Products . . . for *Special* applications

CALEX 410®
dard quality moldable glass-bonded mica insulation.

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tweight moldable glass-bonded mica insulation.

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dard quality machineable glass-bonded mica insulation.

CALEX® K and KM
acitor dielectrics.

LEMETERING EQUIPMENT and COMPONENTS
alex TM55 series commutation switches and SUPRAMICA 555 ceramo- tic commutator plates . . . perfect for low-voltage, low-noise-level ching . . . write to Department 111 for full technical information.

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. . . unexcelled facilities are ready to fill all your insulation requirements . . . short runs or mass production to meet the most stringent tolerances and delivery schedules . . . write to Department 112 for full details.

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THE FIRST SUPRAMICA® CERAMOPLASTIC

SINCE 1919 MYCALEX INSULATION

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Sales Offices: Chicago, Los Angeles, Dayton, Washington

*MYCALEX and SUPRAMICA are registered trade-marks of MYCALEX CORPORATION OF AMERICA for glass-bonded mica and ceramoplastics respectively.

World's largest manufacturer of glass-bonded mica and ceramoplastic products

CONVENIENCE IN COPPER

The next time you order prime surface copper tube you can boost assembly line efficiency by specifying Wolverine long length coils.

Extra-long coils reduce stock chasing to a minimum, free valuable floor space for other duties, cut job make-ready time and help eliminate scrap.

☆ ☆ ☆

This is only one way in which Wolverine can contribute to your manufacturing efficiency. In addition to plain copper tube, you can increase heat transfer performance with Wolverine Trufin®—the integral finned condenser tube.

You can draw from Wolverine's complete fabrication facilities, its packaging program (designed to meet customer production line needs) and, of course, its Field Engineering Service—a staff of technicians ready at all times to help solve tubing problems.

At Wolverine this type of customer service is known as Tubemanship. It is based on years of metalworking experience, constant research, rigid quality control and sound engineering. For complete information about any of Wolverine's many products and services just pick from the booklets listed on the coupon below. Circle the one you need.

Please send me the following book or books:

☐ Commercial Tube Book

☐ Trufin Catalog

☐ Condenser Tube Catalog

☐ Spun End Book

☐ Tubemanship Book

☐ Fabricated Parts Book

☐ Refrigeration Catalog

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Wolverine Trufin available in Canada through the Unifin Tube Company, London, Ontario

CALUMET & HECLA, INC.
CALUMET DIVISION
WOLVERINE TUBE DIVISION
FOREST INDUSTRIES DIVISION
GOODMAN LUMBER COMPANY
CALUMET & HECLA OF CANADA LIMITED
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1439 CENTRAL AVENUE, DETROIT 9, MICH.
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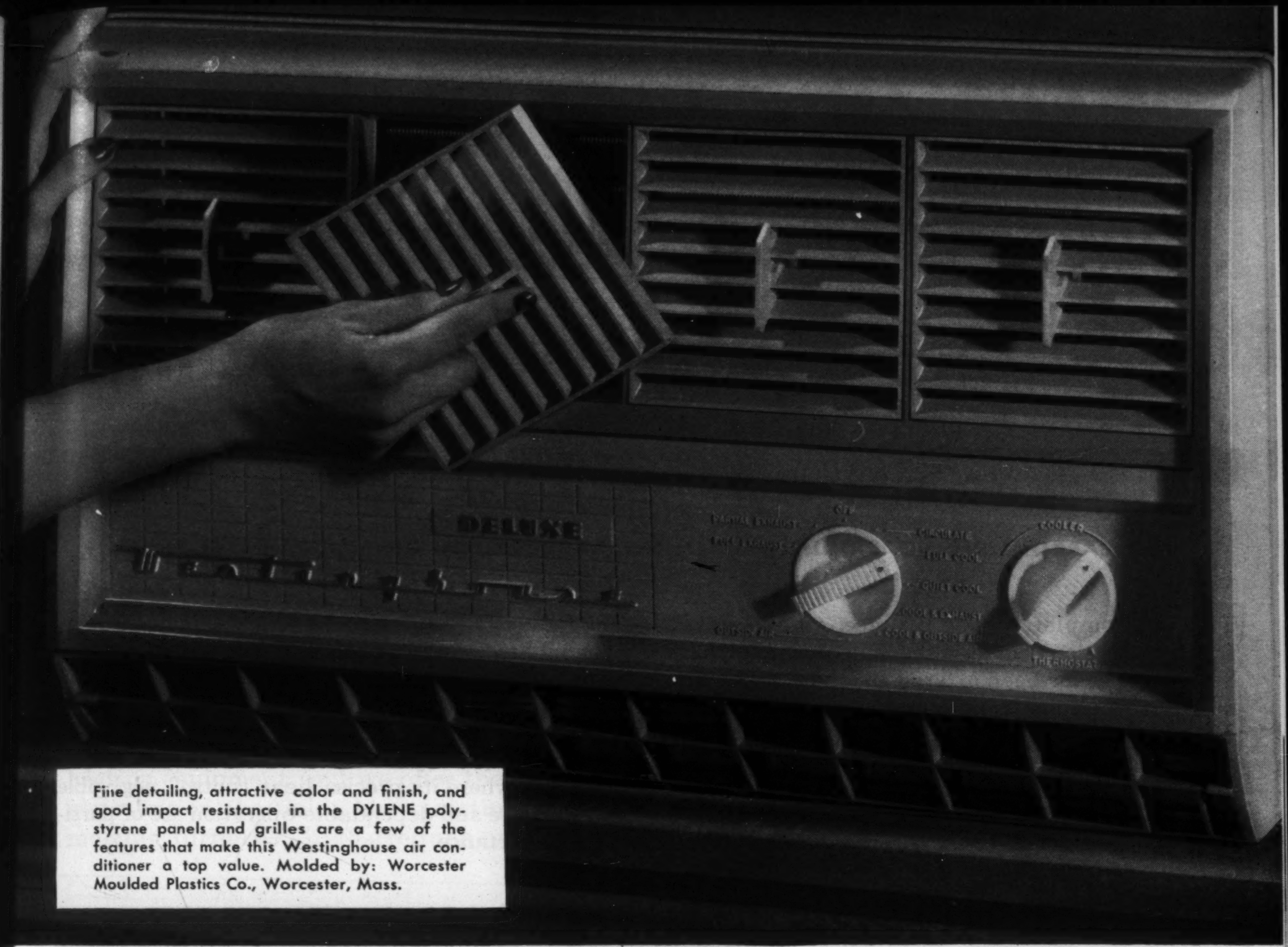
For more information, turn to Reader Service Card, Circle No. 505



Fine detailing, attractive color and finish, and good impact resistance in the DYLENE polystyrene panels and grilles are a few of the features that make this Westinghouse air conditioner a top value. Molded by: Worcester Moulded Plastics Co., Worcester, Mass.

Westinghouse makes sure . . . with **DYLENE**® polystyrene

Finely detailed lettering and design—clean, smooth panel edges—attractive colors—glossy finish and resistance to impact. All of these qualities are found in the polystyrene panel and louvers of the Westinghouse Deluxe Air Conditioner. They are notes of quality that help this product live up to Westinghouse's famous "You can be sure . . ." slogan.

DYLENE polystyrene plastic was chosen as the molding material for several good reasons. It molds easily and sets up fast. DYLENE allows use of fine details such as the 1/8-inch-high raised lettering, and it resists cracking or chipping when the spring-held louvers are allowed to snap into position. DYLENE is colorful and has a finish that is attractive to both touch and sight. No wonder it is used by one of the country's foremost makers of appliances. You, too, can make sure with DYLENE polystyrene.

Koppers also produces DYLITE® expandable polystyrene, DYLAN® polyethylene and SUPER DYLAN* polyethylene. For more information on any of these four fine plastics, write to Koppers Company, Inc., Chemical Division, Dept. MM-126, Pittsburgh 19, Pennsylvania.

**Koppers Trademark*

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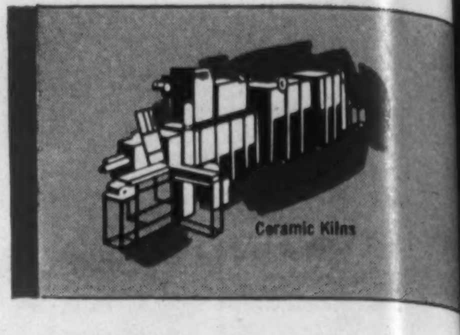
For more information, turn to Reader Service Card, Circle No. 380

BRAND-NEW IDEA in heat treating furnaces



proving again . . .

FOR CARBONITRIDING, BRIGHT HARDENING, CARBURIZING OF SMALL METAL PARTS

This is a completely new furnace, an exclusive Lindberg development. It is the first time induction heating has ever been offered in a heat treating furnace. No elements, no burners, no electrical or gas connections in it. Heating efficiency is high and the furnace can be brought to hardening temperatures in 17 minutes from cold. Temperature control is highly accurate, eliminating temperature override and lag for all practical purposes.

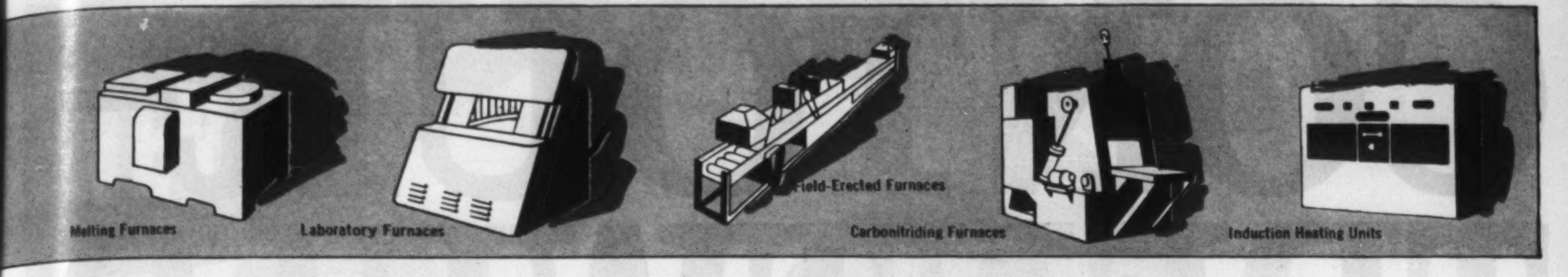
The Induct-O-Ring's circular shape eliminates door-opening heat and atmosphere losses and saves floor space. Work load is automatically charged and moved through the work chamber by a gentle, quiet, reciprocating movement of the furnace. The furnace is completely adaptable to automatic production processes, where its precise heat control, negligible maintenance and dependable operation are of particular importance.

- **No elements, no burners**
- **No gas or electric connections in furnace**
- **Built like a fine machine tool**
- **Precise temperature control**
- **Very low maintenance**
- **Quiet, automatic, trouble-free**

LINDBERG

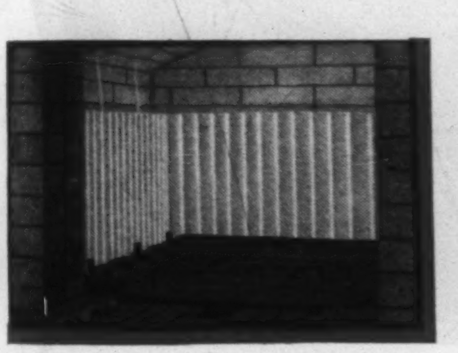
induct-O-ring*

*U. S. and foreign patents pending

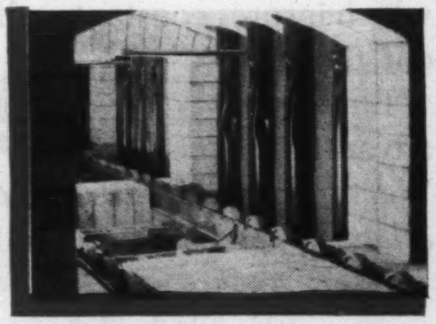


. . . it's better to talk it over with LINDBERG

If you are concerned with the application of heat to industry it makes good sense to talk it over with the most widely experienced experts you can find. We believe we have them here at Lindberg. Our only job is developing industrial heating equipment and we offer the most complete line in the field; heat treating furnaces, melting furnaces, high-frequency induction units, ceramic kilns; big ones, small ones, built in our own plant or field-erected. This gives us the experience and know-how to come up with something really new, like this revolutionary Induct-O-Ring furnace, time and time again. So take your industrial heating problems to the experts. Our engineers and technicians can have the right answer. Talk it over with Lindberg.



Another Lindberg achievement! The use of electricity in carbonitriding and carburizing furnaces has been made completely practical by Lindberg's recent development of the CORRTHERM electric heating element. This element is now being used in many furnace installations where ordinary electric heating elements could not operate successfully.



For fuel-fired furnaces, another important development, the famous "dimple" vertical radiant tube was created by Lindberg. This lightweight, easily-changed tube provides a big advance in furnace efficiency and effects a marked saving in operation and maintenance costs. Minimizes shut-downs and costs for tube changes.

Through the years Lindberg research and development laboratories have originated and perfected many other important heating processes, developments such as the Cyclone tempering furnace, automatic control of carbon potential in furnace atmospheres, 60 cycle induction melting and completely automatic ceramic kilns.

Many important Lindberg developments have come as a direct result of some good customer's need. With the customer's cooperation Lindberg engineers have frequently provided an answer to some pressing production problem. You will benefit, too, whether you need some specific Lindberg equipment or have an industrial heating problem that needs a solution if you'll just talk it over with Lindberg. Call your nearest Lindberg Field Representative. There's one (see your phone book) in every major industrial center.

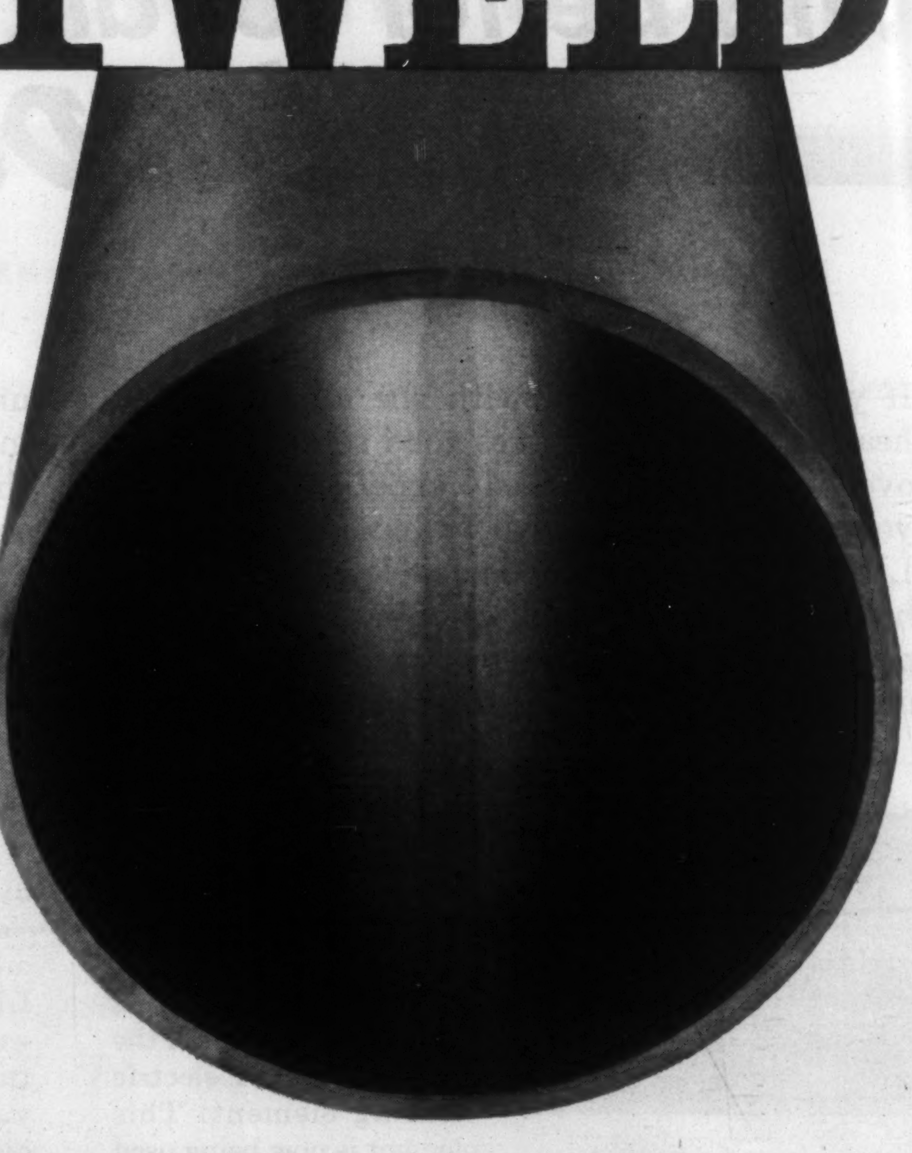
LINDBERG ENGINEERING COMPANY
2451 West Hubbard Street, Chicago 12, Illinois
Los Angeles Plant: 11937 S. Regentview Ave., at Downey, Calif.

Associate Companies: **Lindberg Industrial Corporation, Chicago • EFCO-Lindberg, Ltd., Montreal, Canada • Lindberg Italiana, Milan, Italy • The Electric Furnace Company, Ltd., Weybridge, Surrey, England • Etablissements Jean Aubé, Paris, France • Lindberg Industrie Ofenbau, Gross Auheim, Germany • Toyo Menka, Tokyo • Lindberg Engineering Company (Australia) Pty. Ltd., Melbourne**

For more information, turn to Reader Service Card, Circle No. 563

CONTOUR-TRENTWELD

welded stainless pipe that's smoother, stronger

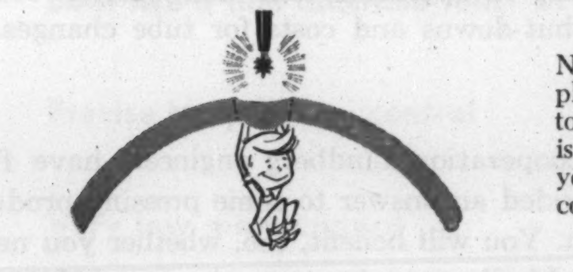


New Contour-Trentweld outperforms any other pipe, welded or not. Here's why: *Contour-Welding* is an entirely unique method of producing pipe and tubing. It puts gravity to work to pull down the molten weld metal until it exactly conforms to the contour of the pipe. Result: A smooth pipe or tube free of undercut or bead.

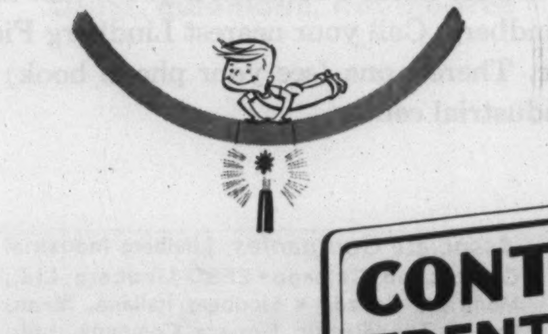
What's more, the *Contour-Weld* process *starts* with uniformly rolled stainless strip, which insures constant wall thickness throughout the pipe.

But the only way you can fully appreciate the advantages of new *Contour-Trentweld* is to try it. We think you'll agree, *it can't be beat by any other pipe, welded or not.*

Why Trent's Exclusive Contour-Welding Process Means Smoother Welds . . .



Normally, in producing welded pipe, the weld is made at the top. But gravity plays a nasty trick. It tugs at the fluid metal in the weld zone, pulling it down toward the middle of the pipe. The result, particularly in the heavier gages, is a perceptible bulge where it hurts the most – right on the I.D. surface. If you try to get rid of the bulge – at fair cost – the metal is undercut – and corrosion and erosion start there.



But Trent put a stop to that – simply by going into partnership with gravity. With their exclusive *Contour-Welding* process, they weld at the bottom – and gravity works for them. For then, the bulge is in the opposite direction – blending in perfectly with the contour of the pipe itself.

CONTOUR TRENTWELD

Stainless and High Alloy Welded Tubing

TRENT TUBE COMPANY, GENERAL SALES OFFICES, EAST TROY, WISCONSIN (Subsidiary of Crucible Steel Company of America)

For more information, turn to Reader Service Card, Circle No. 535

NEW
AMERICAN offers SYNTHETIC FELTS

Thermal Resistance...Chemical Resistance!

Now Available!

- **DACRON***
- **ORLON†**
- **NYLON**
- **ARNEL®**
- **ACRILAN****
- **DYNEL††**

Send today for fact sheets!

*DuPont trademark for its polyester fiber
†DuPont trademark for its acrylic fiber
**®Acrylic fiber by Chemstrand
††Union Carbide's acrylic fiber

Now, American, through its technical research, has perfected the mechanical interlocking of the man-made fibers listed at the left, to produce three-dimensional felt structures.

These new Felts by American have exceptional *chemical resistance* with *thermal stability* to 300 F. They are non-hygroscopic, biologically stable and are available in a complete range of thicknesses. Precision engineering assures close density and thickness control.

The properties which characterize these new Felts are being utilized in filtration—laminated plastics as reinforcing material—high temperature bearing seals—gasketing. In fact, end uses are unlimited!

American's engineering and research staff is prepared to supply you with complete data and product recommendations. Write today!

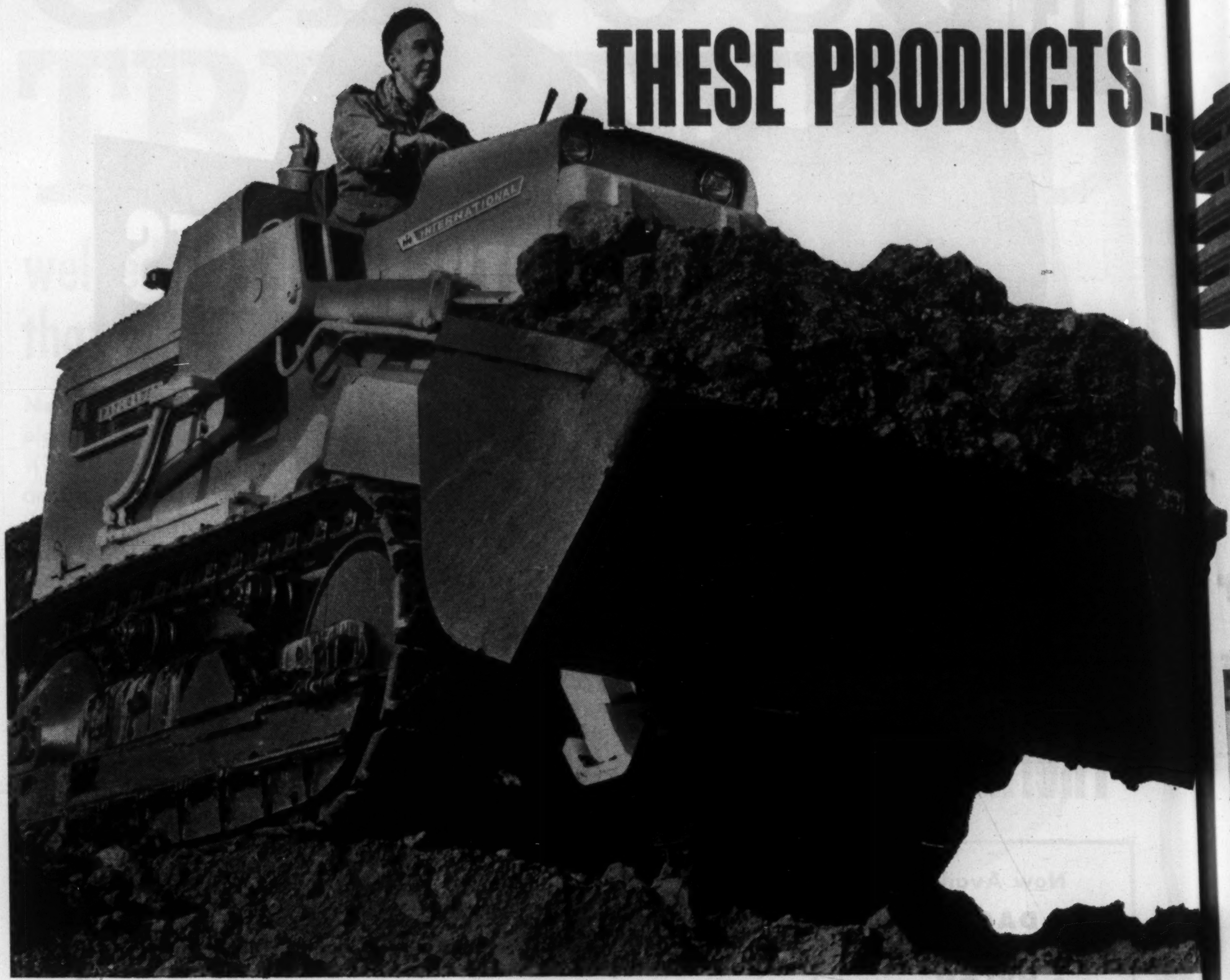
American Felt Company

TRADE MARK ®
GENERAL OFFICES:
24 GLENVILLE ROAD GLENVILLE, CONN.

SALES OFFICES: New York, Boston, Chicago, Detroit, Cleveland, Rochester, Philadelphia, St. Louis, Atlanta, Greenville, S. C., Dallas, San Francisco, Los Angeles, Portland, San Diego, Seattle, Montreal.—PLANTS: Glenville, Conn.; Franklin, Mass.; Newburgh, N. Y.; Detroit, Mich.; Westerly, R. I.—ENGINEERING AND RESEARCH LABORATORIES: Glenville, Conn.

• For more information, turn to Reader Service Card. Circle No. 424

HOW USS "T-1" STEEL IMPROVES THESE PRODUCTS...



Pays Off In Payloader. Speed is emphasized in International Harvester's new Model 12 Payloader. That means weight had to be cut. And USS "T-1" Steel helped cut weight of the rugged boom. This remarkably tough, strong steel is used at top and bottom sides where maximum stresses are imposed. The section depth of the USS "T-1" Steel parts is 12 inches. With other, less strong steels, section depths of 19 and 24 inches would have been required—much too large to fit the contour of the machine. USS "T-1" Steel cut size, weight . . . was cold bent, and welded to other parts of the machine by automatic submerged arc welding.

Stops Brake Breakage. Columbiana Cylinder Grinding Company, Columbiana, Ohio, does a lot of custom machining on industrial and mining equipment, including repair of brake and clutch bands for large earthmoving equipment. On the original equipment these bands are made of plain mild steel . . . often break under the tremendous stresses encountered. Columbiana replaces broken bands with new ones of USS "T-1" Steel—has yet to have a USS "T-1" Steel band break.

For more information, Circle No. 385

More Strength, Less Weight. This lift truck, in use at Baltimore Concrete Plant Corporation, and manufactured by Gerlinger Carrier Company, Dallas, Oregon, is the largest standard-line lift truck on pneumatic tires in the world. USS "T-1" Steel reduced the width and thickness of the forks on this truck. In addition, this extremely tough constructional alloy steel eliminated the need for shipping the forks 75 miles for heat treatment, which was required with the alloy steel previously used.

HOW IT CAN HELP YOU

USS "T-1" Steel, with its high minimum yield strength of 90,000 psi and its minimum tensile strength of 105,000 psi, can help you design or build lighter-weight equipment that will last longer. Its unusual toughness can help you design or build equipment capable of taking severe impact and abuse at sub-zero temperatures. Its excellent weldability can help you cut the cost of fabricating highly stressed parts, and reduce repair and maintenance expense. Its good creep rupture strength can help you put more durability in equipment that operates at temperatures as high as 900 degrees F.

Somewhere in your operation, versatile USS "T-1" Steel can help you. Write, wire, or phone United States Steel, Pittsburgh 30, Pa.

UNITED STATES STEEL CORPORATION, PITTSBURGH • COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO • TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA.
UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS, COAST-TO-COAST • UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS "T1" CONSTRUCTIONAL ALLOY STEEL

USS

See The United States Steel Hour. It's a full-hour TV program presented every other week by United States Steel. Consult your local newspaper for time and station.

UNITED STATES STEEL

star performer

...and among high speed steels REX is the leader

Crucible REX® high speed steel has been the winner in shop tests for more than fifty years. *And now REX is even better than ever!* For Crucible research and experience has led to improved manufacturing techniques that mean higher quality – greater uniformity.

Prove the superiority of REX for yourself – on your next job. Check it for size, structure, response to heat treatment, all-around tool performance. Then you'll know why REX has always been the *standard by which other high speed steels are compared.*

REX is immediately available at all of Crucible's convenient warehouses – or through prompt mill delivery. For a list of available data on REX and other Crucible *special steels,* write for a free copy of the "Crucible Publication Catalog". *Crucible Steel Company of America, The Oliver Building, Mellon Square, Pittsburgh 22, Pa.*

CRUCIBLE **first name in special purpose steels**

Crucible Steel Company of America

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For more information, turn to Reader Service Card, Circle No. 397

Design data on adhesives

Armstrong
ADHESIVES • COATINGS • SEALERS

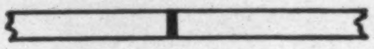
NUMBER FOUR

How to strengthen metal-to-metal joints for flat plates

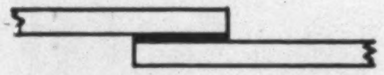
In order to strengthen any joint to be adhesive-bonded, four basic rules must be kept in mind. These rules are:

1. Make the bonded area as large as possible.
2. Make the maximum proportion of bonded area contribute to strength.
3. Stress the adhesive in the direction of its maximum strength.
4. Minimize stress in the direction in which adhesive is weakest.

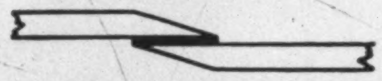
Shown below is a variety of flat plate, metal-to-metal joints to which these rules have been applied.



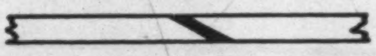
Butt—unsatisfactory



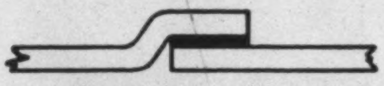
Lap—good, practical



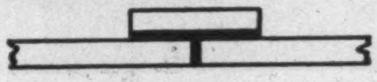
Beveled lap—very good, usually impractical, difficult to machine



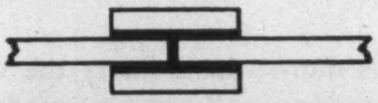
Scarf—very good, usually impractical, difficult to machine



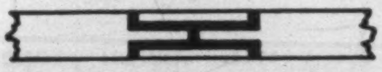
Joggle lap—good, practical



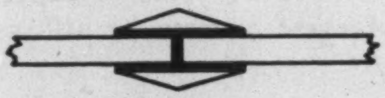
Strap—fair, sometimes desirable



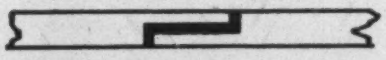
Double strap—good, sometimes desirable



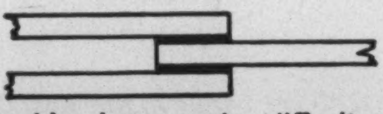
Recessed double strap—good, expensive to machine



Beveled double strap—very good, difficult to produce



Half lap—good, requires machining



Double lap—good, difficult to balance load

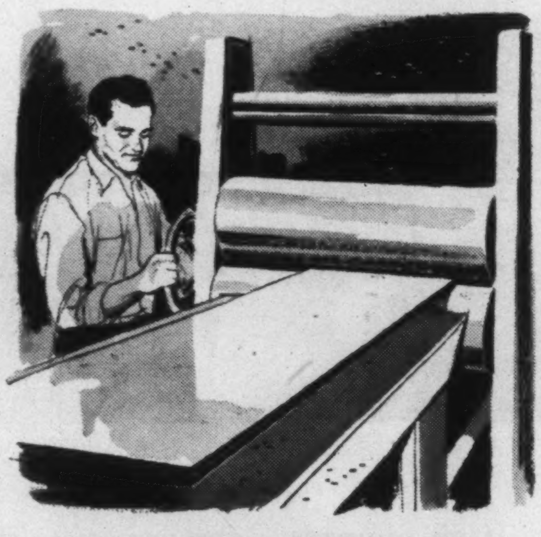
Adhesive bonding: application of pressure

Effective adhesive bonding always requires some pressure. This pressure may be applied to an assembly in any one of several ways, depending on the nature of the adhesive, design of the part, and its size. Hydraulic presses, hydraulic pads, hydraulic cylinders, air cylinders, spring-loaded jigs, air-filled rubber bags and vacuum bags have all been used satisfactorily.

Whatever the method, though, it must meet these three basic requirements: (1) the amount of pressure should be adequate; (2) pressure should be retained at a constant level; and (3) it should be distributed uniformly over the work.

How much pressure?

The amount of pressure required varies with the kind of adhesive and assembly. Some thermosetting adhesives, for example, require relatively high pressure (as high as 200 psi) for times ranging from 15 minutes to several hours. On the other hand, certain thermosetting epoxy-resin adhesives will form a tight bond at room temperatures with only enough pressure to maintain contact. Contact adhesives require high pressures, but only for brief periods. If in doubt about the amount of pressure, check the adhesive manufacturer's recommendations.



KRAFT PAPER HONEYCOMB CORE is being bonded to sheet aluminum. Panel moves between rubber-covered pinch rolls which deliver uniform pressure. This momentary application of pressure is all that's required for some thermoplastic adhesives.

Note: in some sheet metal assemblies, some pressure may be required to straighten warped sheets and bring them into full contact. This pressure should be added to the bonding pressure recommended by the adhesive manufacturer.

For a pressure device to be satisfactory, it must retain pressure at a reasonably constant level during the curing period, because changes take place during curing which can effectively reduce the applied pressure. Most adhesives flow under pressure. As a result, the over-all thickness of the joint may be reduced and the pressure lowered. Pressure must "follow up" such reduction in thickness. Pressure devices which may hold very tightly at room temperatures may loosen and reduce pressure on the joint at elevated temperatures, due to thermal expansion of the parts. Again, some follow-up is required.

Screw-actuated assemblies like clamps and bolted jigs are not satisfactory when used alone. But if used in conjunction with springs, air-filled rubber pads or any other arrangement that will provide follow-up, screw-type devices will give good results.

Uniform distribution

Uniform distribution of pressure is most important. High and low pressure spots within an assembly can result in lack of uniform contact and differing film thickness—which may result in variability of bond strength. With rigid fixtures or dies, a "pressure pad" like chipboard, rubber-fabric compounds, or glass cloth may have to be interposed between the face of the fixture and the work to equalize pressure. Assemblies bonded in vacuum bags or autoclaves, with the pressure applied directly to the bond and not through fixtures, have excellent pressure distribution.

For more information

Write for a copy of "Armstrong Adhesives, Coatings, and Sealers." Armstrong Cork Company, 8012 Dunbar St., Lancaster, Penna.

For more information, turn to Reader Service Card, Circle No. 437

Birth of 113

At this stage, #113 is just a number. If all proceeds as planned, it will shortly acquire a name — the name of Driver-Harris's newest special-purpose alloy . . . made, as always, to meet the needs of a specific manufacturer.

When someone asks us for an alloy we do not have, we try to make it. Usually we succeed. To date we have succeeded 112 times. Many of our long line of electrical, electronic, and heat-resistant alloys — Nichrome*, Nichrome* V, Advance*, Karma*, Manganin, Nilvar*, and the rest — are today famous names in industry the world over. And each of these was originally custom-made . . . produced exactly to the specifications of someone who needed it.

Are you in need of an alloy with special properties, not yet available? Put your specifications in our hands. You will gain the benefit of the 57 years of experience which has developed the largest variety of alloys ever made by any one company.

*T.M. Reg. U. S. Pat. Off.

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MAKERS OF THE MOST COMPLETE LINE OF ELECTRIC HEATING, RESISTANCE, AND ELECTRONIC ALLOYS IN THE WORLD

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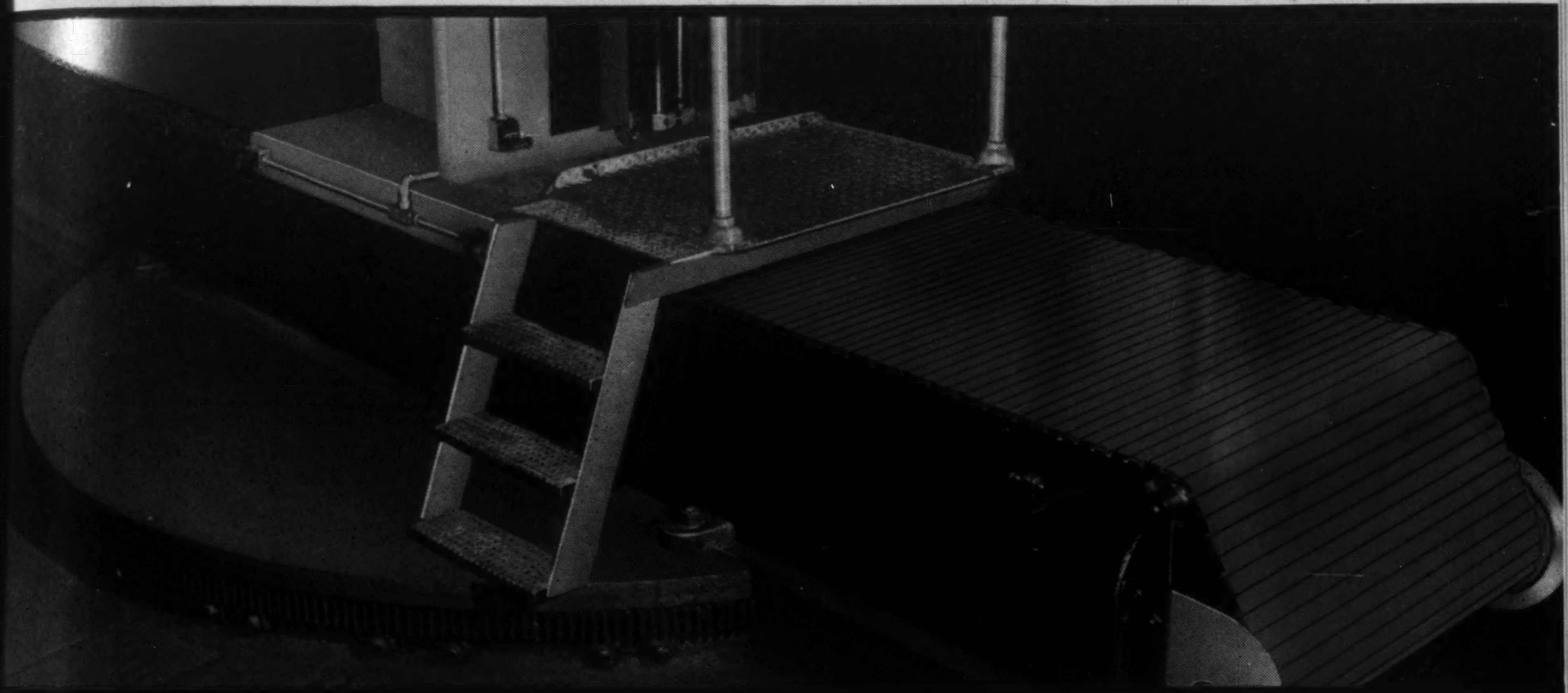
Futurmill "Way-Life" Covers– Made Better for Less with Reynolds Aluminum Extrusions



Engineers at Futurmill, Inc. of Pontiac, Mich. and Reynolds Designers put their heads together to take advantage of the amazing flexibility of aluminum extrusions . . . to make "Way-Life" Covers provide better protection for machine ways . . . at lower cost.

The result of this cooperative effort: 1½" wide interlocking extruded slats of 6063-T5 aluminum—flexible enough to provide custom made covers of any length or width—covers that roll up compactly at either end of a machine. They are strong yet lightweight . . . strong enough for machine operators to walk on safely for job set-up . . . light enough to make covers easy to install. They will not stretch or tear . . . hot chips will not burn them.

Fabrication of the covers simply requires cutting the slats to length, riveting a small section of another aluminum extrusion to the ends of every other slat—to prevent sideway movement—and assembling the interlocking slats. Reynolds• engineers designed the aluminum end extrusion to replace a casting—at a savings of $0.05 per piece.

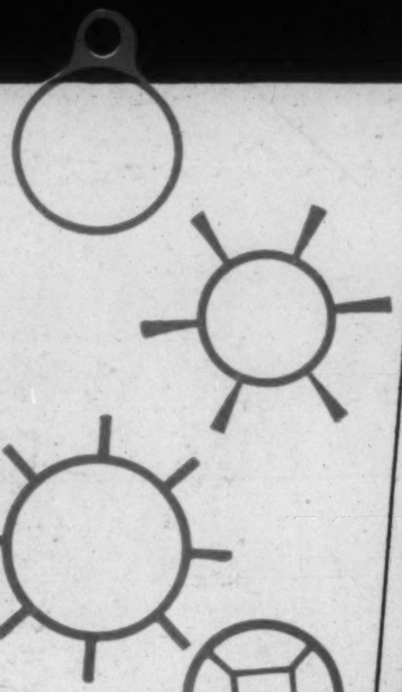
Consider improving your product with aluminum extrusions—from Reynolds. Remember, aluminum extrusions offer infinite *flexibility* of design . . . and Reynolds engineers offer invaluable *experience* in design.

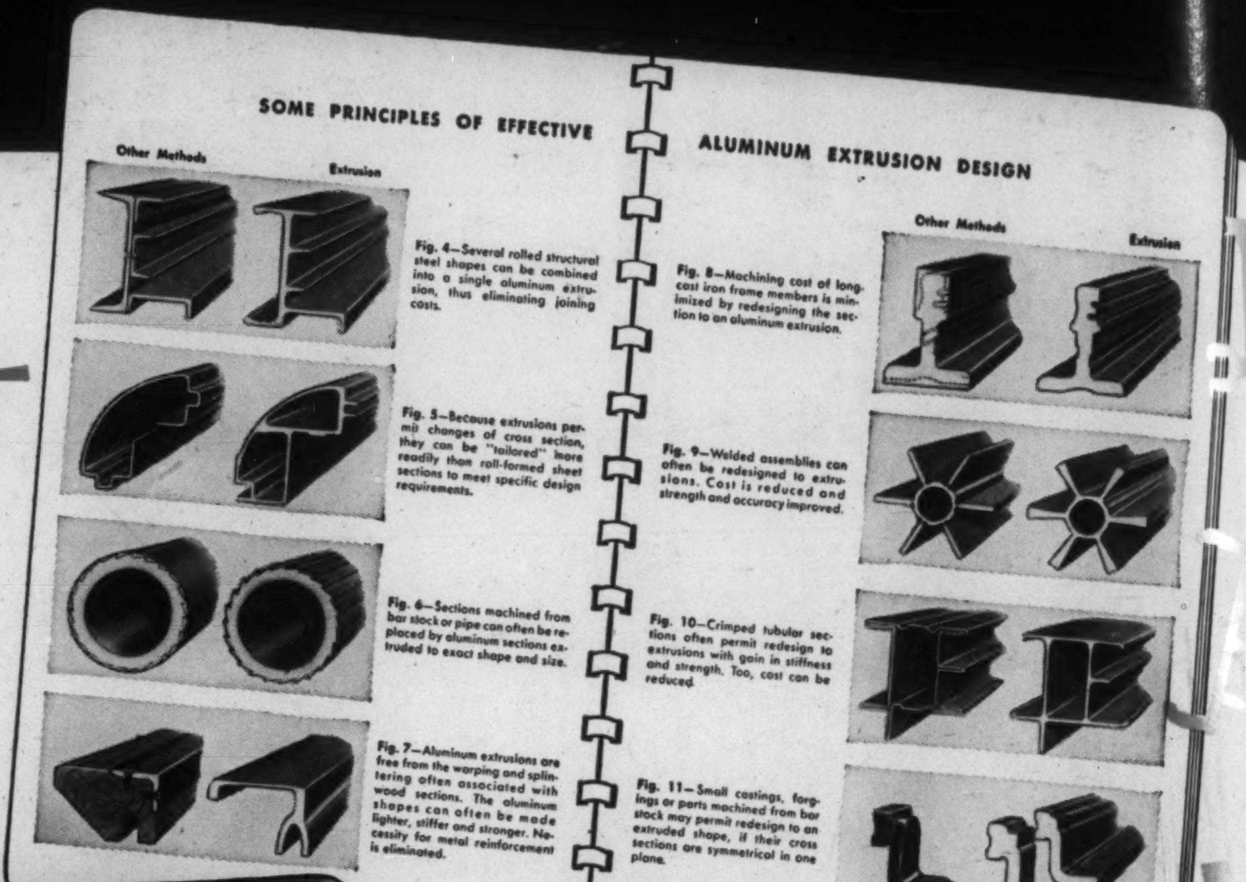
For more information about aluminum extrusions and Reynolds Design and Engineering service, consult the nearest Reynolds Office listed under "Aluminum" in classified telephone directories. Or write *Reynolds Metals Company, P.O. Box 1800-HM, Louisville 1, Ky.*

The Finest Products
Made with Aluminum
are made with
REYNOLDS ALUMINUM

See Reynolds New Program, "Circus Boy", Sundays on NBC-TV

How to Take Advantage of Aluminum Extrusions





SOME PRINCIPLES OF EFFECTIVE ALUMINUM EXTRUSION DESIGN

Other Methods — Extrusion

Fig. 4—Several rolled structural steel shapes can be combined into a single aluminum extrusion, thus eliminating joining costs.

Fig. 5—Because extrusions permit changes of cross section, they can be "tailored" more readily than roll-formed sheet sections to meet specific design requirements.

Fig. 6—Sections machined from bar stock or pipe can often be replaced by aluminum sections extruded to exact shape and size.

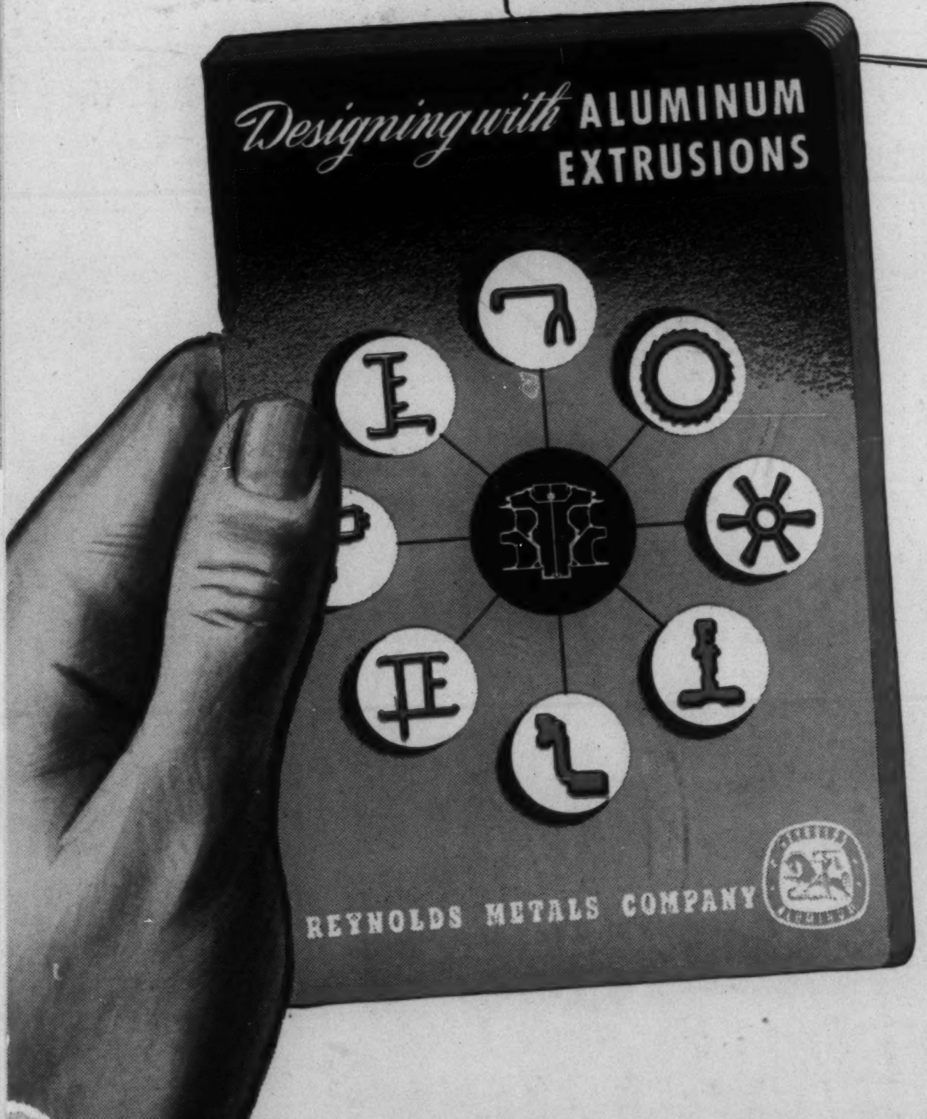
Fig. 7—Aluminum extrusions are free from the warping and splintering often associated with wood sections. The aluminum shapes can often be made lighter, stiffer and stronger. Necessity for metal reinforcement is eliminated.

Fig. 8—Machining cost of long cast iron frame members is minimized by redesigning the section to an aluminum extrusion.

Fig. 9—Welded assemblies can often be redesigned to extrusions. Cost is reduced and strength and accuracy improved.

Fig. 10—Crimped tubular sections often permit redesign to extrusions with gain in stiffness and strength. Too, cost can be reduced.

Fig. 11—Small castings, forgings or parts machined from bar stock may permit redesign to an extruded shape, if their cross sections are symmetrical in one plane.



138 Page Reynolds Handbook Shows How to Increase Design Efficiency ...Lower Production Costs

Limitations of rolled structural shapes, formed sheet sections and machined, cast or welded parts are soon forgotten when you thumb through the authoritative handbook, "Designing With Aluminum Extrusions." The many important advantages obtainable with extrusions are shown in the above pages reproduced from the book.

Extrusion dies are inexpensive, so special shapes that use the metal most efficiently can be produced economically. The handbook shows how . . . with 126 illustrations and chapters on Features of Aluminum Extrusions; Examples of Effective Extrusion Design; Manufacturing Possibilities; Shape Design from Manufacturing Standpoint; Structural Design Considerations; Finishes; Cost Factors and a wealth of other essential data.

Your free copy of "Designing With Aluminum Extrusions" is available, along with a complete index of other helpful Reynolds literature, when requested on a business letterhead. Simply write to *Reynolds Metals Company, P. O. Box 1800-HM, Louisville 1, Kentucky.*

The Finest Products
Made with Aluminum
are made with
REYNOLDS ALUMINUM

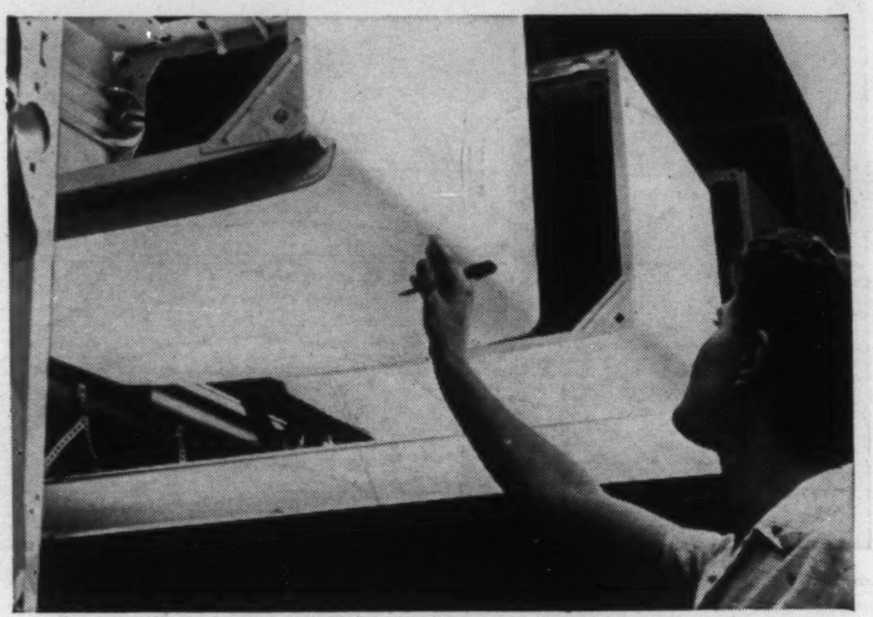
See Reynolds New Program, "Circus Boy", Sundays on NBC-TV

EPON® RESIN does it!

RCA WHIRLPOOL Washer cabinets on storage conveyors. Finish system includes an Epon resin undercoat, formulated by Grand Rapids Varnish Corporation.

Tough primer on RCA WHIRLPOOL Washers

withstands rugged washday punishment



Epon resin-based finish plus careful inspection eliminate customer complaints.

HERE'S HOW...

SOAPS AND MODERN high-strength detergents are persistent enemies of ordinary paint. Because of severe corrosive conditions in some geographical areas, home laundry appliances often show rust stains in just a few weeks of service.

Whirlpool-Seeger Corporation, St. Joseph, Michigan, has found that a primer based on Epon resin gives an outstandingly superior protective finish to its washers, driers, and other home laundry equipment. To maintain the highest standards for coatings, Whirlpool-Seeger set up a system of continuous quality-control testing in their finishing section.

Epon resin-based primers, now standard on RCA WHIRLPOOL Washers, are credited with all but eliminating a major source of field complaints about coating failures.

• • •

If you have a product finishing or paint maintenance problem, you, too, may find that Epon resin-based coatings will do the job better. They have excellent adhesion, high resistance to impact and abrasion, outstanding resistance to moisture, heat, and corrosives. Ask your supplier for Epon resin-based paints and enamels. Write for the full Epon resin coatings story: "*Planning to Paint a Pyramid?*"

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Chemical Division, Shell Oil Company of Canada, Limited
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Epon resins are the epoxy polymers made exclusively by Shell Chemical Corp.

For more information, turn to Reader Service Card, Circle No. 376

Should you be using...
...ALITE?

If you require a material with properties such as these:

- **LOW DIELECTRIC LOSS FACTOR**
- **HIGH TEMPERATURE STABILITY**
- **EXTREME HARDNESS**
- **EXCELLENT CORROSION RESISTANCE**

—it would be well to investigate the possibilities of Alite.

The Alites are a series of sintered metallic oxides developed by The U. S. Stoneware Co. Because Alite possesses the unique combination of electrical and physical properties above, it is finding increasing use in critical applications involving stringent electronic and/or mechanical requirements.

Alite retains its mechanical characteristics at working temperatures well above 2000° F. It maintains low loss characteristics throughout the entire spectrum, into the microwave range. In addition to giving durable service as high-strength insulating components, Alite is used for rotating seals, pump plungers, slide valves, crucibles, sleeve bearings, bushings, extrusion dies, etc.

We can form Alite to practically any shape by extruding, pressing, molding or casting. It can be finished to precision tolerances by diamond wheel grinding and lapping. Alite is abrasion-resistant, vacuum-tight, can be metalized and brazed to metal components.

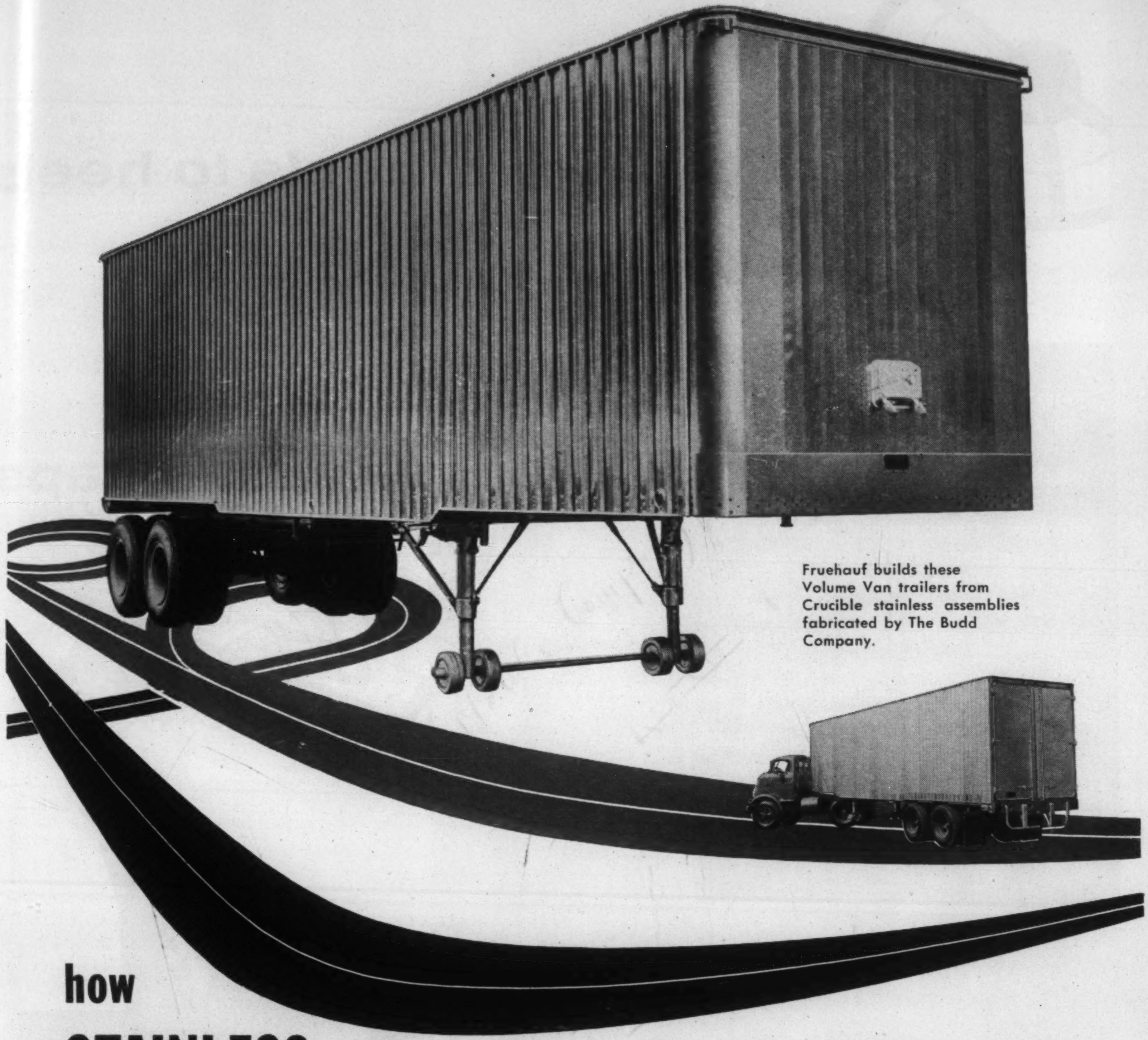
If "heat-barrier" problems or mechanical limitations forestall improved performance of your product or application, *consider designing for Alite*. We'll furnish complete data promptly. Write today for Bulletin A-7.

382-E

ALITE DIVISION

U. S. STONEWARE
AKRON 9, OHIO

For more information, turn to Reader Service Card, Circle No. 381



Fruehauf builds these Volume Van trailers from Crucible stainless assemblies fabricated by The Budd Company.

how STAINLESS adds payload capacity—lowers costs

Cargo capacity and profits go hand-in-hand in the transportation field. And stainless steel's high-strength gives this Fruehauf *Volume Van* trailer construction advantages that add up to carrying capacity above that of other van type trailers.

Stainless steel provides extreme rigidity and toughness, yet reduces dimensions of side walls, roof tension sheets, and front and rear panels. As Fruehauf says:

"Not only is there a gain in cubic capacity as well as strength, but an actual saving in weight so that the net result of the complete design is a transportation unit which will provide the highest possible return on the initial investment."

And stainless lasts indefinitely. In fact, there's a tradition in the industry that "no stainless steel trailer has ever worn out." For stainless resists wear, fights corrosion, takes a lot of punishment before it will scratch or dent. Maintenance is greatly reduced.

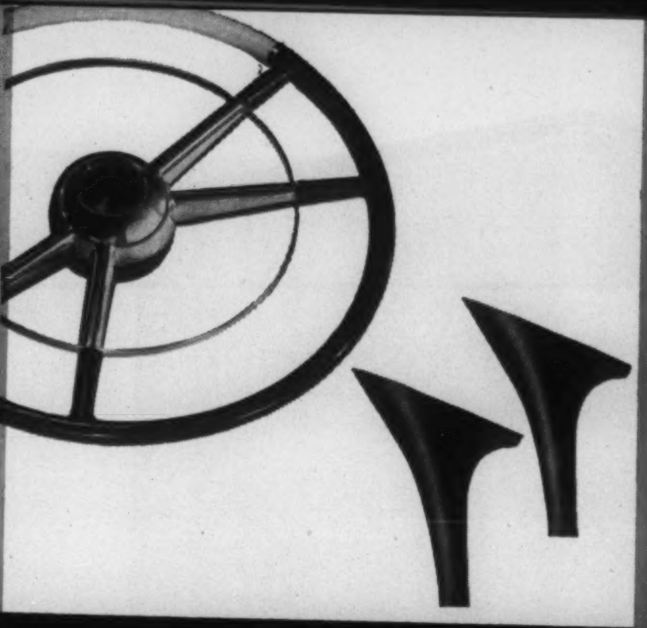
Should your product use stainless? It may be the answer to greater efficiency, lower costs, a more attractive product for you, too. Ask your local Crucible representative, or write *Crucible Steel Company of America, The Oliver Building, Mellon Square, Pittsburgh 22, Pa.*

CRUCIBLE first name in special purpose steels

Crucible Steel Company of America

Canadian Distributor — Railway & Power Engineering Corp., Ltd.

For more information, turn to Reader Service Card, Circle No. 483

# From wheels to heels.

TENITE BUTYRATE is characterized by extreme toughness, high impact strength, resilience, light weight, weather resistance, dimensional stability, lustrous surface...and an unlimited range of transparent, translucent, opaque, metallic and variegated colors plus crystal transparent.

Available in a wide variety of formulations to meet many different use requirements.

Adapted to the fastest injection molding, or continuous extrusion.

Typical uses: steering wheels, telephones, business machine keys, football helmets, oilers, tool handles, marine floats, oil-field and industrial pipe, toys, furniture parts.

from wraps to caps.

WHITE BEAR
freezer paper
POLYETHYLENE LAMINATED
Ginger Ale

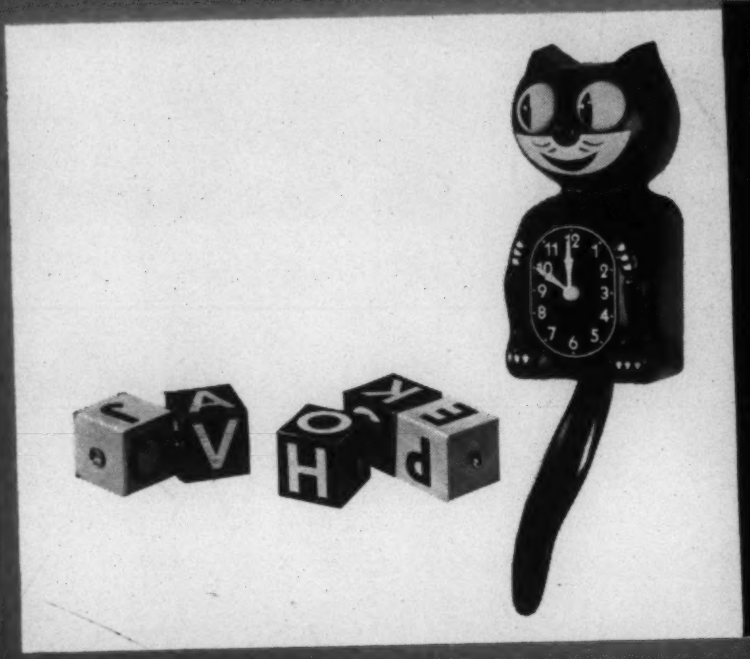
TENITE POLYETHYLENE is characterized by flexibility or semi-rigidity as desired, resistance to breakage, chemical inertness, excellent electrical properties, superior resistance to moisture vapor transmission, resistance to strong acids.

Available in the form of spherical pellets which flow freely in machine hopper...in natural or a wide variety of colors and color concentrates, with or without an antioxidant.

Adapted to rapid injection molding, blow molding, or continuous extrusion.

Typical uses: housewares, toys, packaging film, bottles, pipe and tubing, wire and cable insulation, paper coatings.

from blocks to clocks . . .



TENITE ACETATE is the original Tenite plastic, offering a wide range of desirable properties including toughness, light weight, impact strength, enduring luster and low heat conductivity.

Like Tenite Butyrate, available in an unlimited range of colors and a wide variety of formulations to satisfy different use requirements.

Typical uses: appliance housings and parts, shoe heels, toys, novelties.

. . . products made of Tenite plastics offer extra sales appeal, in the form of brighter colors, greater strength, and longer life

TENITE

ACETATE • BUTYRATE • POLYETHYLENE

plastics by Eastman

EASTMAN CHEMICAL PRODUCTS, INC., subsidiary of Eastman Kodak Company, KINGSPORT, TENNESSEE

For more information, Circle No. 479

TOO
FAR
FOR
ORDINARY
MATERIALS

Official U. S. Navy photograph.

Versatile KEL-F® fluorocarbons help solve complex design problems

KEL-F Fluorocarbon Products are a family of Molding Plastics, Plastic Dispersions, Oils, Waxes, Greases, Elastomers, Chemicals and Printing Inks.

Based on the extremely stable trifluorochloroethylene polymers, these fluorocarbon materials are engineered to withstand high temperatures and corrosive atmospheres. The entire KEL-F Fluorocarbon Family also possesses individual properties that make them indispensable in meeting a variety of the most rigid engineering specifications.

A Wide Variety Of Uses

The protection afforded by KEL-F Fluorocarbon Products is well established in the aviation field in a wide variety of applications. Included among these are acid and high-energy fuel hoses, seals, O-rings, diaphragms, coverings for micro-switches, wire insulation, electronic components, laminated lined containers and compressor lubricants.

When your design problems involve elevated temperatures . . . corrosive fuels . . . vibrational shock . . . high humidity . . . aerodynamic loading —Kellogg is ready to help you find the answers. Write for further information.

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For more information, turn to Reader Service Card, Circle No. 500

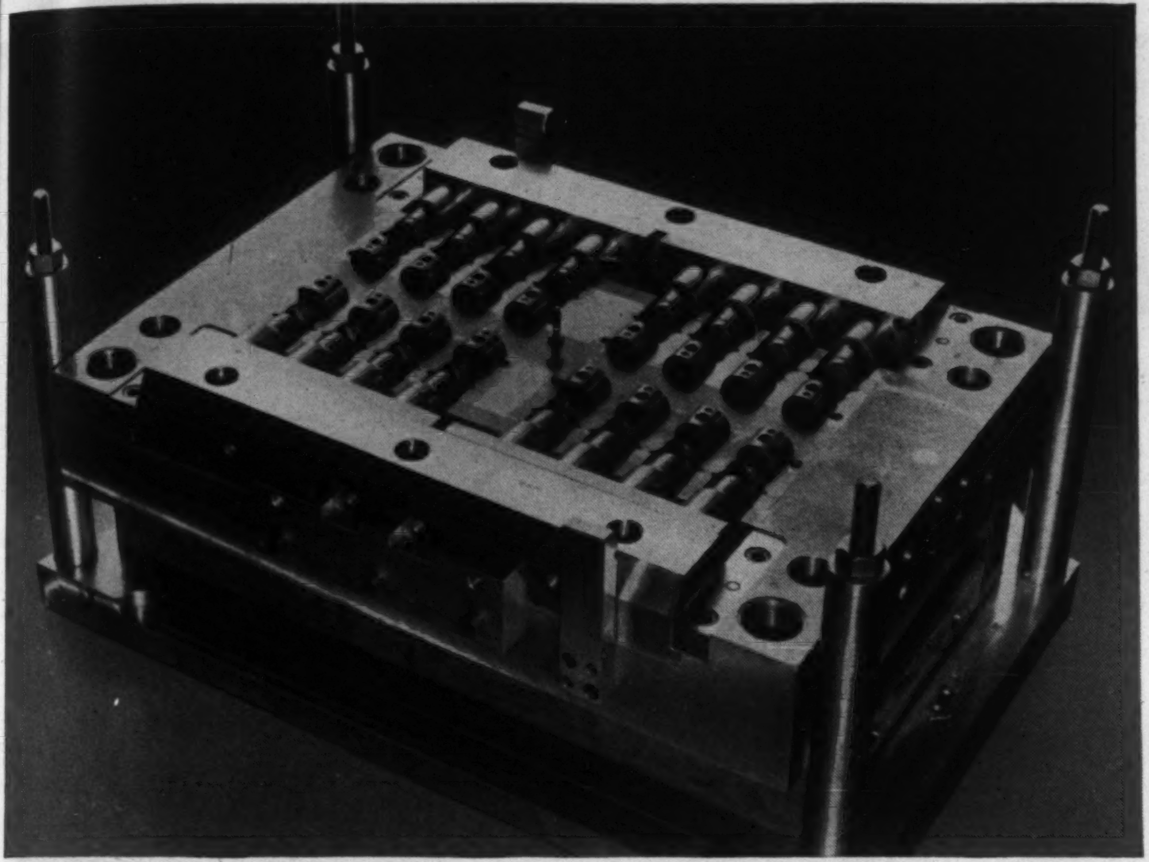
Tool Steel Topics

BETHLEHEM STEEL

the Pacific Coast Bethlehem products are sold
Bethlehem Pacific Coast Steel Corporation

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

Export Distributor:
Bethlehem Steel Export Corporation



This die, made from Lustre-Die by Eagle Tool and Machine Co., Hillside, N. J., produces plastic part shown below.

Lustre-Die Tool Steel Fills Bill for Makers of Plastic Parts

So you're looking for high lustre! Just wait until you see the job you get when you use Lustre-Die, Bethlehem's new plastic-molding tool steel.

Lustre-Die is ideal tool steel for making plastic parts because it has properties which enable it to take such a high polish. One glance at Lustre-Die and you'll think you're looking in a mirror.

Sturdy and good looking, this plastic section for detergent can top was made from die of Lustre-Die.

Lustre-Die is a special, electric-furnace steel of well-balanced analysis. It is alloy-fortified to increase its depth of hardenability and mechanical properties. It is also heat-treated by means of oil-quenching and tempering to a hardness of Brinell 302-352.

BASIC ANALYSIS

Carbon 0.50 Manganese 1.00 Silicon 0.30
Chromium 1.10 Molybdenum 0.25
(plus Alloy-Fortification)

Lustre-Die is such a clean, clean steel. It is carefully inspected to ensure freedom from porosity or surface pitting. Machining is easy, too, as the steel is free from nickel. Besides, there are no additives to cause inclusions, which could cause spotty areas on the die surface.

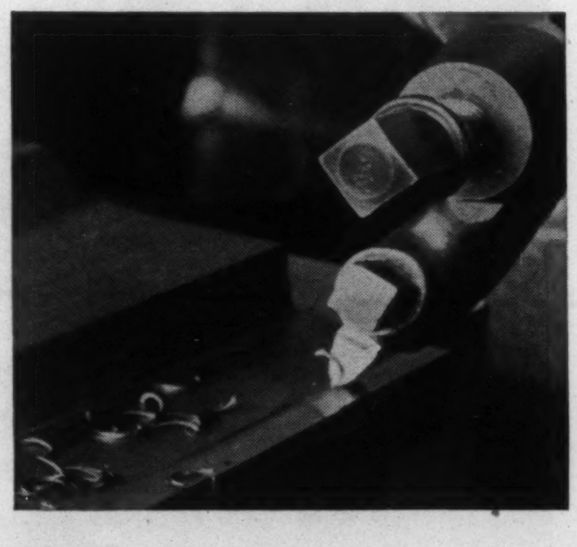
If you would like to purchase a trial piece of Lustre-Die, simply get in touch with your Bethlehem tool steel distributor.

BETHLEHEM TOOL STEEL ENGINEER SAYS:

Unusual Metal "Pickup" on Tools Is Caused By Carburization

Metal "pickup" occurring on the surface of tools used in shearing, blanking or forming metal can be an annoying problem. When such "pickup" is routine and expected, it is customary to provide continuous maintenance to remove the adhering metal. But when it suddenly occurs in an operation normally free from "pickup," the trouble can be serious.

Recent investigations have shown that the most common cause of unusual "pickup" on tools is the unsuspected presence of an unwanted carburized case, unintentionally placed on the tools during heat-treatment, and therefore not removed by grinding after heat-treatment. On many grades of tool steel, a high carbon case causes retained austenite to form during heat-treatment. As the austenite is very soft, its presence on the surface of otherwise hard tools is sufficient reason to account for metal "pickup." A regrinding operation on the tool usually removes the austenitic skin, eliminating the trouble.



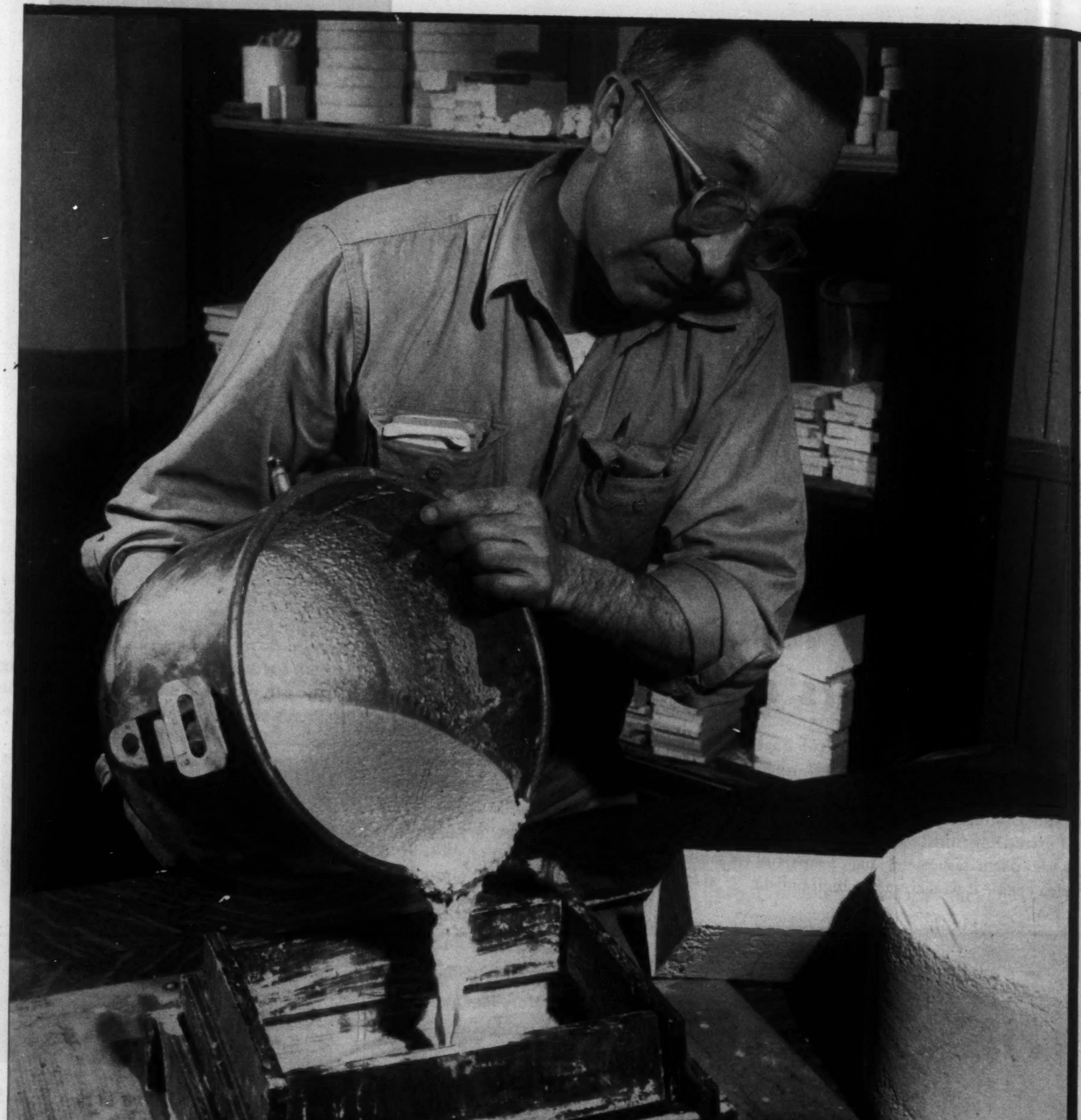
GOOD RESULTS WITH 66 HS

Bethlehem 66 HS (High-Speed) tool bits can always be counted on for smooth, steady cutting. In the operation illustrated, the 66 HS bit is shaping a bending die. 66 HS, because of its well-rounded 6-5-4-2 analysis, has all the properties needed for economical high-speed work.

For more information, turn to Reader Service Card, Circle No. 365

Two vital newcomers for your furnace operations

New ALUNDUM*



Castables...33-I and 33-HD

are easy to use, protect up to 3300° F, eliminate costly pre-fired shapes and bring you other big savings

New, Norton-engineered 33-I and 33-HD ALUNDUM Castables offer exceptional advantages to the ceramic, metals and chemical processing industries where high temperature furnaces are used. These new high temperature Castables are designed for working face areas and back-up in such furnaces.

Both types are easy to mix and work. Both require only inexpensive forms for making simple or intricate shapes. Both dry fast, enabling you to prepare furnace areas quickly. And their ability to provide new highs in temperature protection, to replace many pre-fired shapes, and to assure long trouble-free service gives you steady, worthwhile savings.

ALUNDUM 33-I
Insulating Castable

is made up primarily of pure aluminum oxide bubbles. These countless tiny bubbles form a network of air spaces which are light in weight and provide excellent insulation, even at highest commercial temperatures. These qualities make 33-I ideal for lightweight furnace construction, where it stands up under radiated high temperatures or erosion by mild flame and gas. It gives excellent protection to service face applications, and as a back-up for ALUNDUM 33-HD Castable or for high purity pre-fired ALUNDUM shapes.

ALUNDUM 33-HD
Heavy Duty Castable

is also chiefly composed of pure aluminum oxide, but of dense grain material, which makes it heavier duty than 33-I. In fact, 33-HD is the most efficient Castable for forming dense monolithic surfaces in the construction of many types of high temperature furnaces, especially where operating conditions are severe.

Characteristics of ALUNDUM Castables

	33-I	33-HD
Density (as cast and dried)	100 lbs. per cu. ft.	170 lbs. per cu. ft.
Water added per 100 lbs.	18 pts.	11 pts.
Stiffens	1 hr.	1 hr.
Initial set	4 hrs.	4 hrs.
Final set	18-24 hrs.	14-24 hrs.
Shrinkage (as cast)	0%	0%
Grain size	6F	6F
Chemical analysis — Al_2O_3	primarily	primarily
SiO_2	<0.1%	<0.10%
Fe_2O_3	<0.1%	<0.15%
Maximum hot face temperature	3300°F	3300°F

Get all the facts

A new Norton folder on ALUNDUM 33-I and 33-HD Castables is now ready to be sent to you. It gives you all the information you want on these new Castables — describes and illustrates exactly how you can mix and work them, and contains interesting charts of their linear shrinkage, modulus of rupture and thermal conductivity. These facts tell you just how you can improve your high temperature furnace operation, at lower costs. Write for your free copy to NORTON COMPANY, Refractories Division, 352 New Bond Street, Worcester 6, Mass. *Canadian Representative:* A. P. Green Fire Brick Co., Ltd., Toronto, Ontario.

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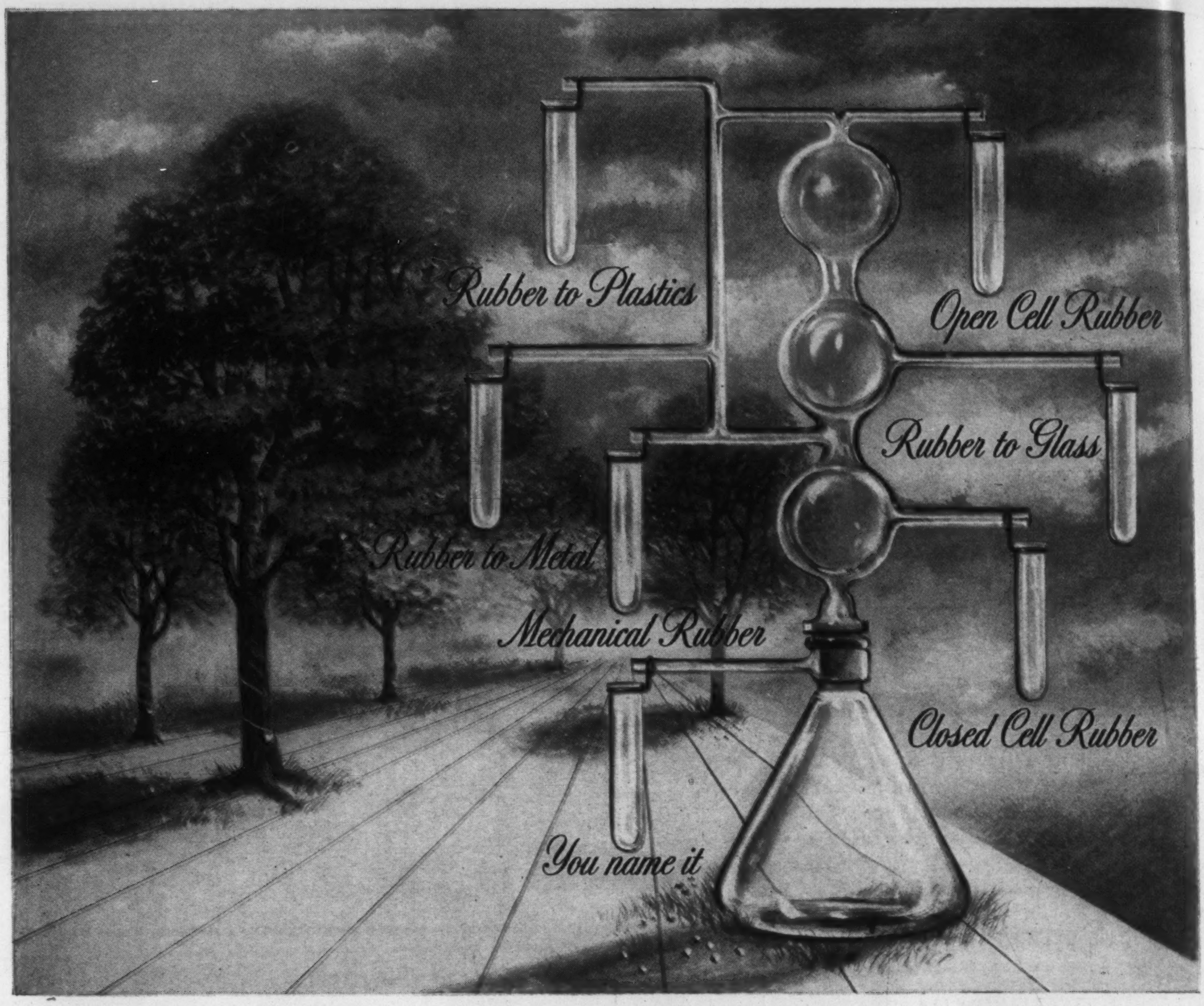

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These are some of the jobs that our specialty rubber products are doing for others and can do for you. Our range of products includes cellular and mechanical types — hard as ebonite, soft as a sponge — using natural or synthetic latices.

We are not only equipped to develop special rubber compounds, but also to convert them into finished parts — by sheeting, blanking, forming, molding or laminating. *For more details about our specialty rubber products and services, please write Dept. M for our booklet "Engineered Rubber Specialties."*

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SHOE MATERIALS—for Counters, Midsoles, Liners, etc.
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RUBBER—for Floats, Grommets, Gaskets, Bearing Seals, etc.

SERVICES

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NATCO ENGINEERS

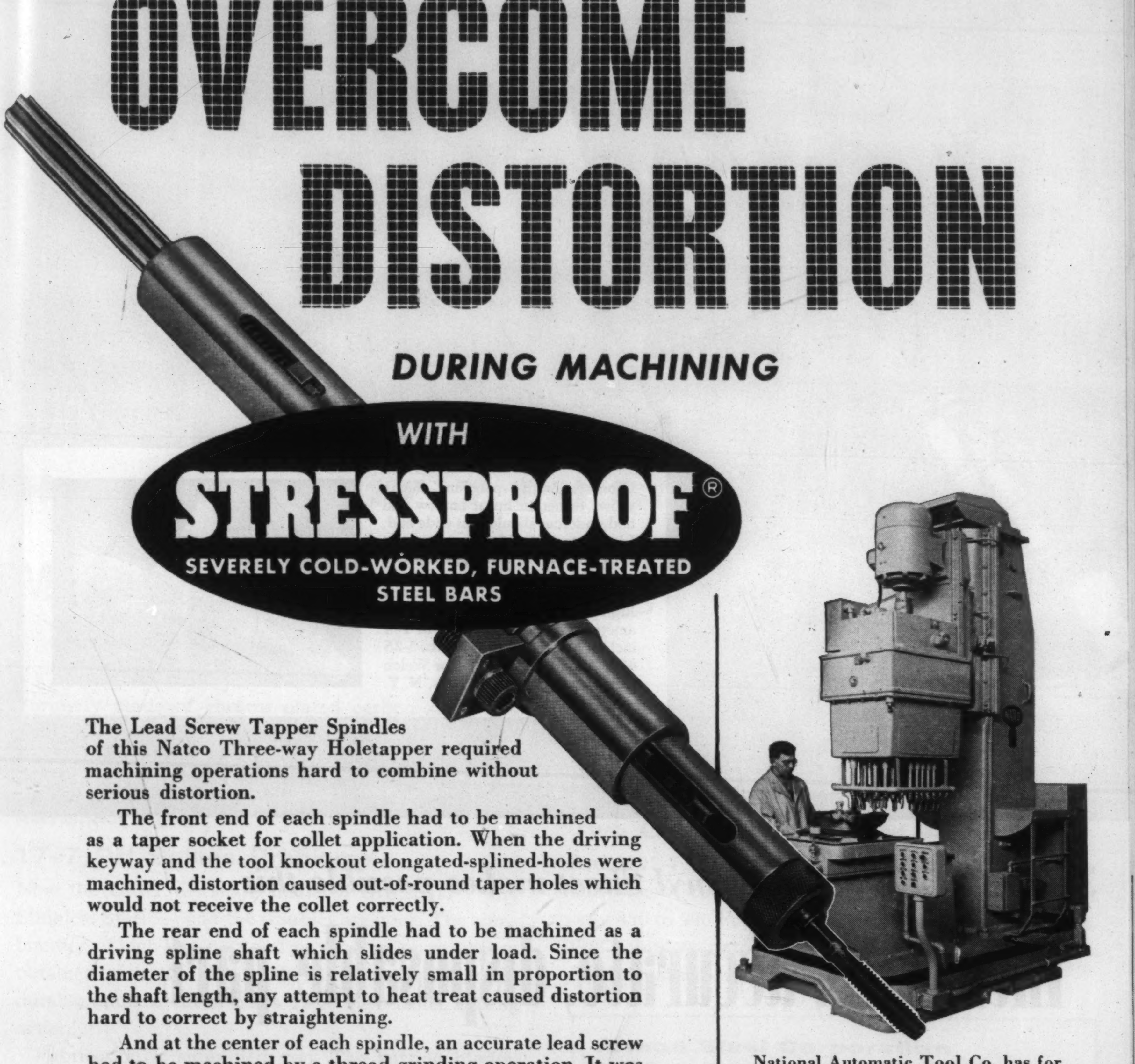
OVERCOME DISTORTION

DURING MACHINING

WITH

STRESSPROOF®

SEVERELY COLD-WORKED, FURNACE-TREATED
STEEL BARS



The Lead Screw Tapper Spindles of this Natco Three-way Holetapper required machining operations hard to combine without serious distortion.

The front end of each spindle had to be machined as a taper socket for collet application. When the driving keyway and the tool knockout elongated-splined-holes were machined, distortion caused out-of-round taper holes which would not receive the collet correctly.

The rear end of each spindle had to be machined as a driving spline shaft which slides under load. Since the diameter of the spline is relatively small in proportion to the shaft length, any attempt to heat treat caused distortion hard to correct by straightening.

And at the center of each spindle, an accurate lead screw had to be machined by a thread grinding operation. It was found that the finish was much more easily obtained when STRESSPROOF was used.

STRESSPROOF eliminated both the problem of the out-of-round taper holes on the front of each spindle . . and the distortion of the driving-spline-shaft.

STRESSPROOF makes a better part at a lower cost.

National Automatic Tool Co. has for many years used STRESSPROOF in the manufacture of important operating parts for this Three-way Holetapper, as well as for other Natco high-speed machine tools.

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CUT COSTS
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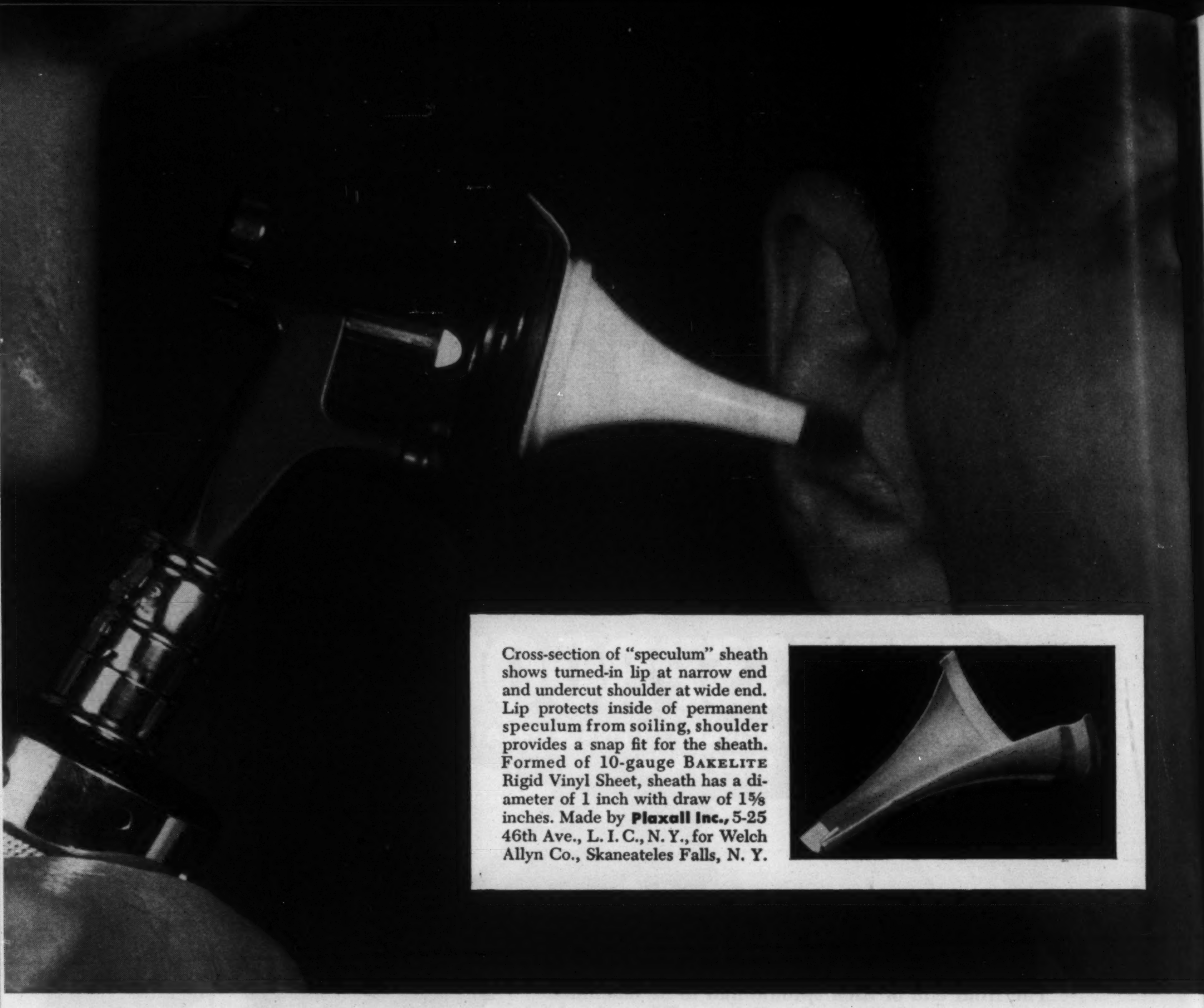

Cross-section of "speculum" sheath shows turned-in lip at narrow end and undercut shoulder at wide end. Lip protects inside of permanent speculum from soiling, shoulder provides a snap fit for the sheath. Formed of 10-gauge BAKELITE Rigid Vinyl Sheet, sheath has a diameter of 1 inch with draw of 1⅝ inches. Made by **Plaxall Inc.,** 5-25 46th Ave., L. I. C., N. Y., for Welch Allyn Co., Skaneateles Falls, N. Y.

***BAKELITE** BRAND Rigid Vinyl Sheet makes possible this*

Intricate, accurate, disposable part

The design idea is a reality because BAKELITE Brand Rigid Vinyl Sheet was the only material that could be vacuum-formed to so deep a draw, according to the manufacturer. It's a sanitary disposable sheath for the "speculum" of an "otoscope" used in ear examinations.

These sheaths cost only a little over a cent apiece because pressure-forming BAKELITE Rigid Vinyl Sheets is such a fast, low-cost process. Notice the deep, complex draw. Precise, too. The sheath works in close quarters. It has to be thin, tight-fitting, and strong enough to be snapped onto the speculum without crinkling or tearing.

One material—BAKELITE Rigid Vinyl Sheet—met all requirements. In addition, its service properties include *dimensional stability* and resistance to water, oil, and chemicals. Clear transparent, as well as colored translucent and opaque sheet stock is available. Learn more about it by writing Dept. VU-108.

B
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PLASTICS

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In Canada: Bakelite Company, Division of Union Carbide Canada Limited, Belleville, Ontario
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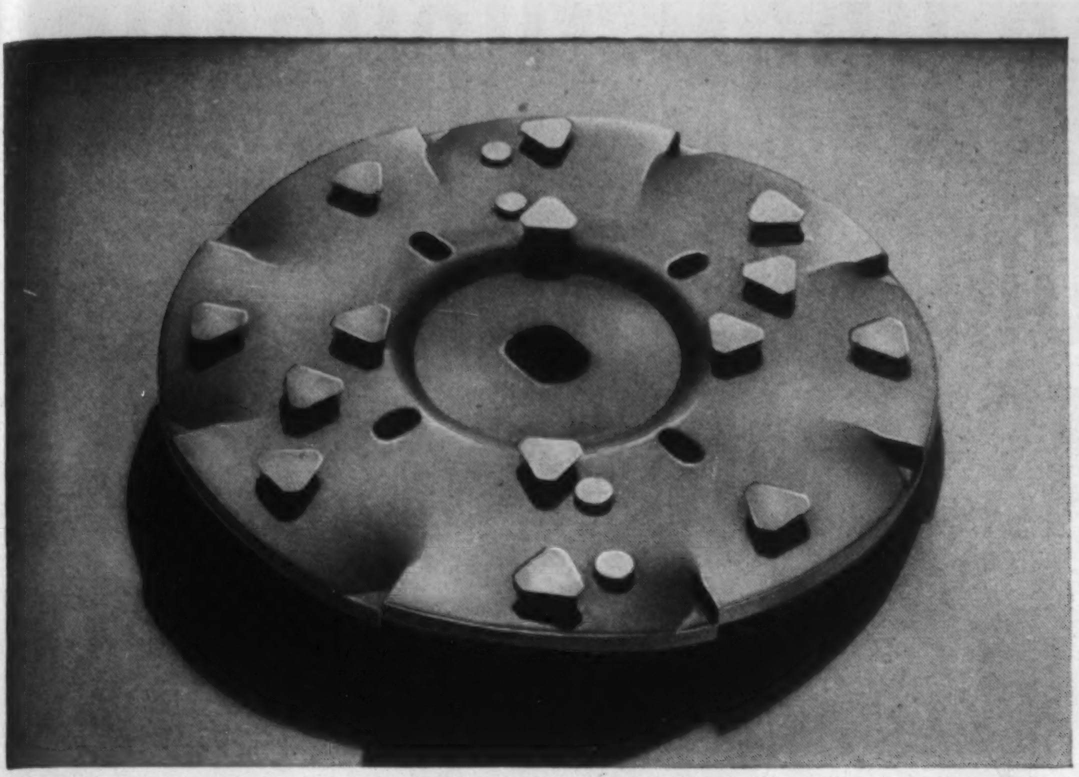

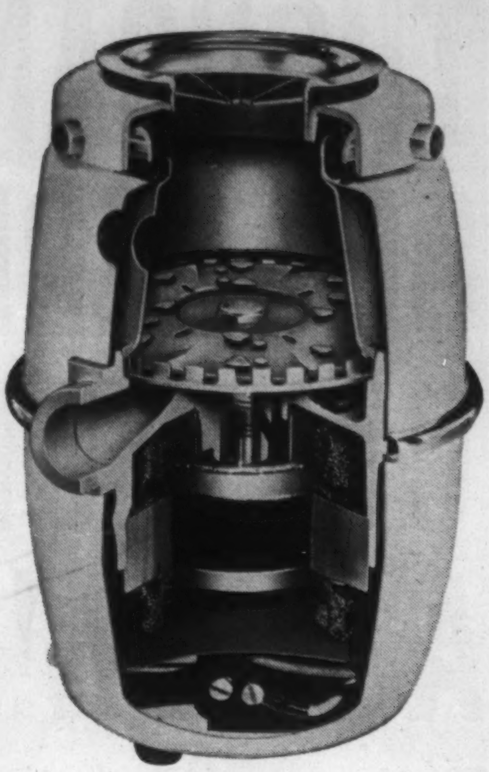

How Armco 17-7 PH Stainless

Makes this part Last Longer, Work Better

Formerly made of chrome-plated carbon steel, this cutter disc for a food waste disposer was reducing the efficiency of the unit. The combination of corrosion and abrasion in grinding food wastes dulled the carbon steel cutting edges.

17-7 PH Solves Problems

Now the cutter discs are made of Armco 17-7 PH Stainless Steel . . . and the troubles are gone. The combination of high hardness and good corrosion resistance obtained with 17-7 PH makes the part much more durable and the cutter has a 15 to 20% faster cutting action.

Fabrication is simplified, too. The cutting blades, 17-7 PH cold-headed rivets, are attached to the formed 17-7 PH disc. Then the assembly is hardened. A simple heat treatment at 1400 and 950 F hardens the entire part to Rockwell C 40.

Unusual Properties

This cutter disc is typical of the improved performance and production you can obtain by utilizing the unusual combination of properties you get in Armco 17-7 PH. Extra high strength and hardness, good corrosion resistance and excellent fabricating characteristics give you many new opportunities to improve your product and reduce manufacturing costs as well.

Two Grades Available at Armco

Armco 17-7 PH is supplied in sheet, strip, plates, bars and wire. A companion grade, 17-4 PH—hardened at only 850 to 900 F, is produced in bars, wire and billets. For complete data on these special Armco Stainless Steels, just fill out and mail the coupon.

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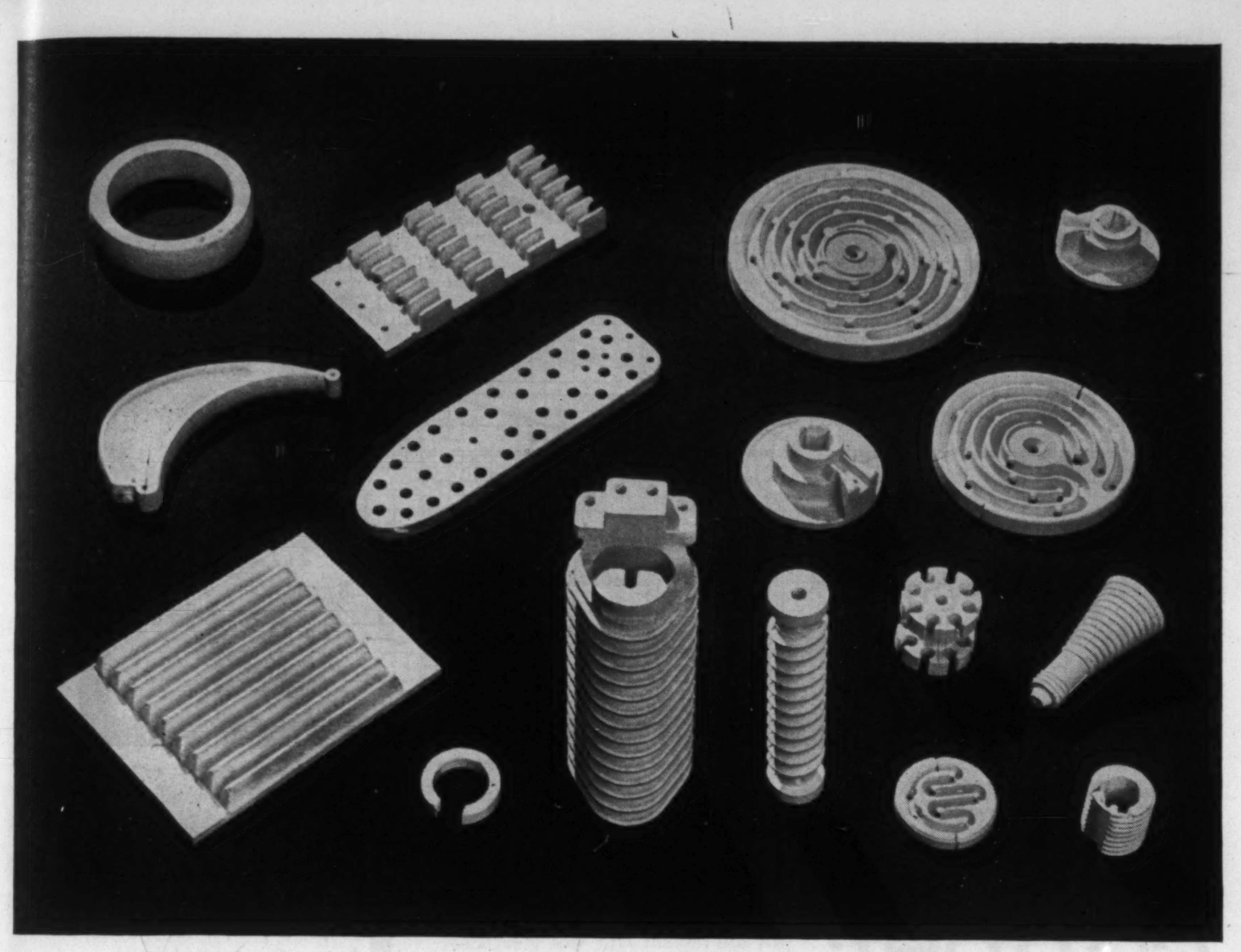
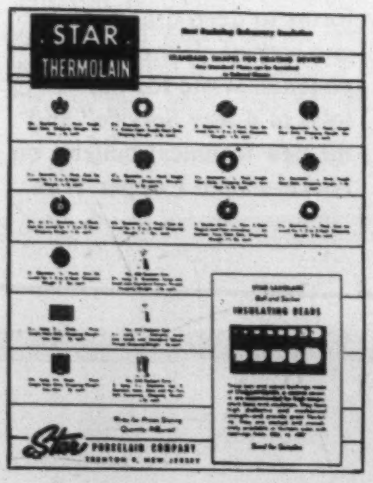


when the heat's on ...



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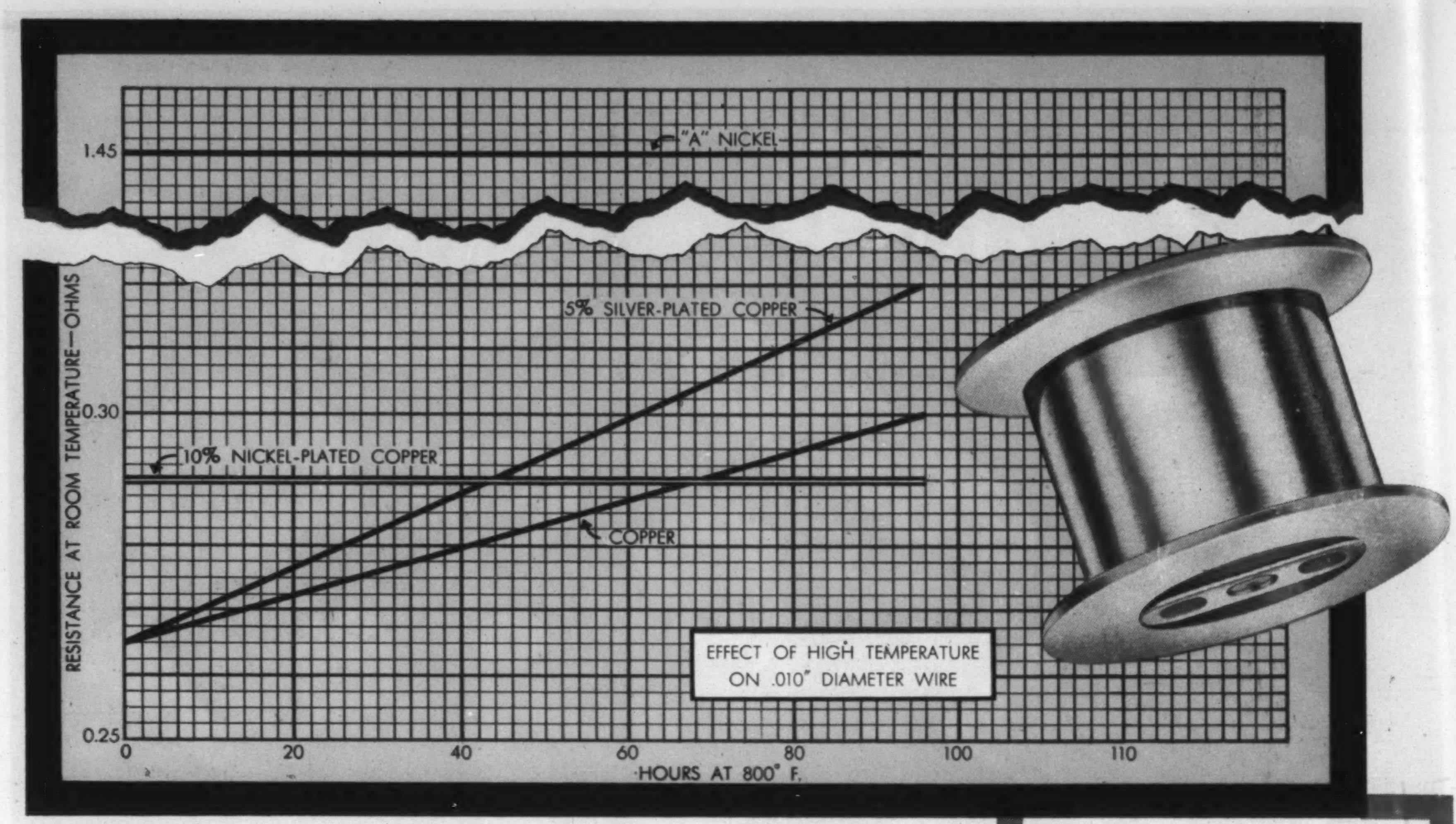

Nickel-plated copper...

for high conductivity at elevated temperatures

SYLVANIA's Nickel-plated copper wire combines the conductivity of copper with the corrosion-resistant properties of nickel for applications involving temperatures ranging from 350° Fahrenheit to 700° Fahrenheit.

Equal lengths of Nickel-plated copper and three other wires were heated in air at 800° Fahrenheit for an extended period to determine the effect of heat on conductivity.

Nickel-plated copper, more than any of the other wires except for pure nickel, holds its original low resistance. It's this feature which, in many cases, has made Nickel-plated copper more desirable than costlier wires used where conductivity must remain constant under high temperature environment.

Nickel-plated copper wire can be supplied in a full range of diameters from .250" to .005".

Sylvania is the only major wire supplier with complete facilities for plating and cladding wire. This makes it possible to provide you with an experienced, objective recommendation as to whether a plated or a clad wire is best suited for your application.

In addition, Sylvania's Parts Division offers you complete 4-way service including custom molded plastic parts, small metal parts ranging from wire forms to deep drawn parts, and special electronic components. Write for the "Portfolio of 4-way Service" and the new technical bulletin on Nickel-Plated Copper Wire.

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Sylvania Electric Products Inc., Parts Division, Warren, Pennsylvania

SPECIAL WIRE
METAL STAMPINGS
MOLDED PLASTIC
ELECTRONIC COMPONENTS
4-way service from one source

For more information, turn to Reader Service Card, Circle No. 555

DESIGNING WITH ALUMINUM

This is one of a series of information sheets which discuss the properties of aluminum and its alloys with relation to design. Extra or missing copies of the series supplied on request. Address: Advertising Dept., Kaiser Aluminum & Chemical Sales, Inc., 1924 Broadway, Oakland 12, California.

NO. 22

ANODIZING ALUMINUM

One of the most appealing characteristics of aluminum is the ease with which a variety of surface finishes may be applied to it.

Among these finishes is one that is used almost exclusively for aluminum: anodizing. It is the electrolytic formation on the metal of an oxide film which is relatively thick compared to the natural oxide film formed in normal environments.

The natural oxide film, which begins to form on aluminum surfaces as soon as they are exposed to air, provides a thin, transparent, protective covering for the metal. This film, which may be only a millionth of an inch thick, accounts for aluminum's resistance to corrosion.

The thicker film produced by anodizing provides still greater anti-corrosion characteristics, plus a hard, wear-resistant surface. This anodized film may vary considerably in thickness, hardness and porosity, depending upon the anodizing process used. These processes are similar in that, in each of them, an electric current is passed between the aluminum and an electrolytic bath in which the aluminum is immersed as an anode. There are also distinct differences among the processes, such as the variety of electrolyte baths which may be used.

Sulfuric Acid Process

The sulfuric acid anodizing process is used to create a relatively thick, porous coating.

Sulfuric acid anodic films serve as excellent mordants for certain classes of dyes which, when absorbed in the coating pores, give bright attractive colors to the aluminum surface.

However, because most dyes will fade in direct sunlight, they should not be used in outdoor applications where fading over a period of several years may become a problem.

Relatively low cost makes this anodizing process the one most widely used commercially. Virtually all decorative anodizing is done in dilute sulfuric acid baths. Coatings produced by this process provide effective barriers to many corrosive atmospheres. Thin films produced in sulfuric acid are excellent surface pre-treatments for subsequent paint, enamel and lacquer coatings.

Because of the corrosive nature of the electrolyte, the sulfuric acid process should not be used for anodizing assemblies wherein bath entrapment might be possible.

Chromic Acid Process

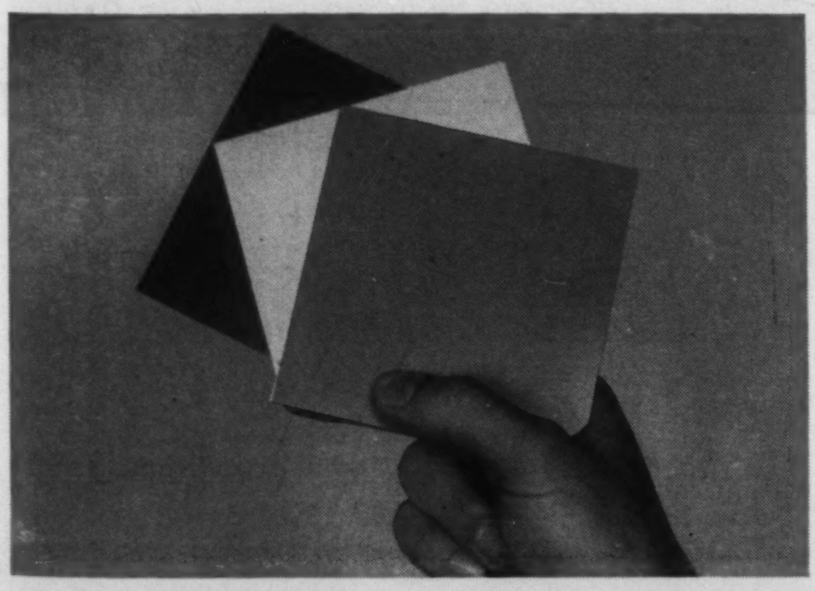
Anodic coatings produced in chromic acid baths are noted for their outstanding resistance to corrosion, which may be attributed to a lesser degree of porosity than sulfuric acid anodic films.

This reduced porosity limits the value of chromic acid coatings for dyeing, but they are widely used as base coatings for paints, enamels, etc. In fact, many armed services specifications include chromic acid anodic coatings as paint primers.

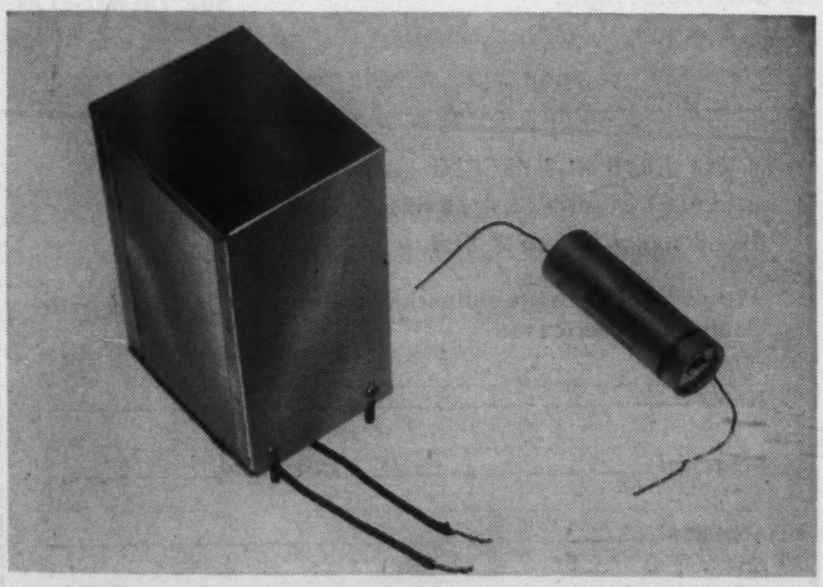
Although higher operating voltage requirements render this process more costly than the sulfuric acid process, it is frequently used for anodizing intricate shapes that are to be exposed to extremely corrosive environments. Because the bath acts as a corrosion inhibitor, there is no danger of corrosion being caused by bath entrapment in crevices.

Hard-Coat Processes

The hard-coat processes developed fairly recently are used to create heavy, highly abrasion-resistant films.



Anodized coatings can be formed in various shades ranging from colorless transparent to dark gray, depending upon the choice of aluminum alloy, electrolyte solution and anodizing conditions.



At one time, capacitors for use in electronic equipment were quite bulky (above left). Space and weight are now saved through use of anodized aluminum foil capacitors (above right) which are much more efficient.

DESIGNING WITH ALUMINUM No. 22 (Continued)

Kaiser Aluminum

With the added attribute of extreme resistance to corrosion, the hard-coats are especially useful in extending the service life of moving machinery parts. Hard-coats are currently being used on cylinders and pistons, hydraulic systems, textile machinery rolls and other applications requiring great wear-resistance.

To date, hard-coat processes are comparatively expensive. Both the voltage and current density used are quite high, and there is considerable expense connected with the refrigerating equipment required to maintain the bath temperature at about 30°F. or lower.

Boric Acid Process

Coatings formed by anodizing in boric acid solutions are nonporous, and have high dielectric strength.

Their use represents one of the specialized applications of the properties of anodic coatings. Etched aluminum foil, anodized in a boric acid solution, is now used in the production of electrolytic capacitors, or condensers. These are much more efficient and considerably smaller than earlier paper-wound capacitors. Their reduced size has had an important influence on the design of the compact radios, television sets and aviation electronic apparatus we use today.

Gold Coat Process

An improved anodizing process recently announced by Kaiser Aluminum makes use of a new decorative alloy to produce a striking gold color during anodizing. This gold color is remarkably lightfast —*far superior to dyes* in its resistance to ultraviolet light.

The anodizing processes that produce this gold color are low in cost and require only the standard equipment used in sulfuric acid anodizing.

Phosphoric Acid Process

Because the anodic oxide coatings formed in phosphoric acid are appreciably soluble in the anodizing bath, they are thin and highly porous—not sufficiently attractive to be used in decorative applications without subsequent finishing treatments.

An advantage of their thinness and porosity is in affording a good base for electroplating adherent layers of other metals, such as nickel, copper, silver and cadmium. In preparing pre-plating anodic coatings of this type, the anodizing characteristics of the individual aluminum alloys must be considered.

Desired results can be obtained by varying anodizing conditions such as bath concentration, temperature, voltage, etc. The most satisfactory plating solutions for use with phosphoric acid anodized coatings are those that are nearly neutral or only weakly acid or alkaline.

The processes described here are only a few of the many techniques used to create anodic coatings. There are many variables in each process, and specific control of all or any of the variables may be exercised to obtain certain desired effects. For further information concerning specific anodizing techniques, contact the Kaiser Aluminum sales office or distributor listed in your telephone directory. Kaiser Aluminum & Chemical Sales, Inc., *General Sales Office*, Palmolive Bldg., Chicago 11, Illinois; *Executive Office*, Kaiser Bldg., Oakland 12, California.

ANODIZING CONDITIONS

Process	Bath Composition	Voltage	Current Density Amp/Ft^2	Special Conditions or Equipment
Sulfuric Acid	15% H_2SO_4	14–17[1]	12	....
Chromic Acid	5 to 10% CrO_3	0–40	1–5	Bath temperature 95°F.
Boric Acid	12%	500	10.8	Bath temperature 210°F.
Hard Coats	10–20% H_2SO_4	23 to 120	20–50	Refrigeration equipment to maintain temp. 25 to 30°F.
Phosphoric Acid	17–43% P_2O_5	5–30	10–20	Bath temperature 60–95°F.

[1] Depending on the alloy

See *"THE KAISER ALUMINUM HOUR."* Alternate Tuesdays, NBC Network. Consult your local TV listing.

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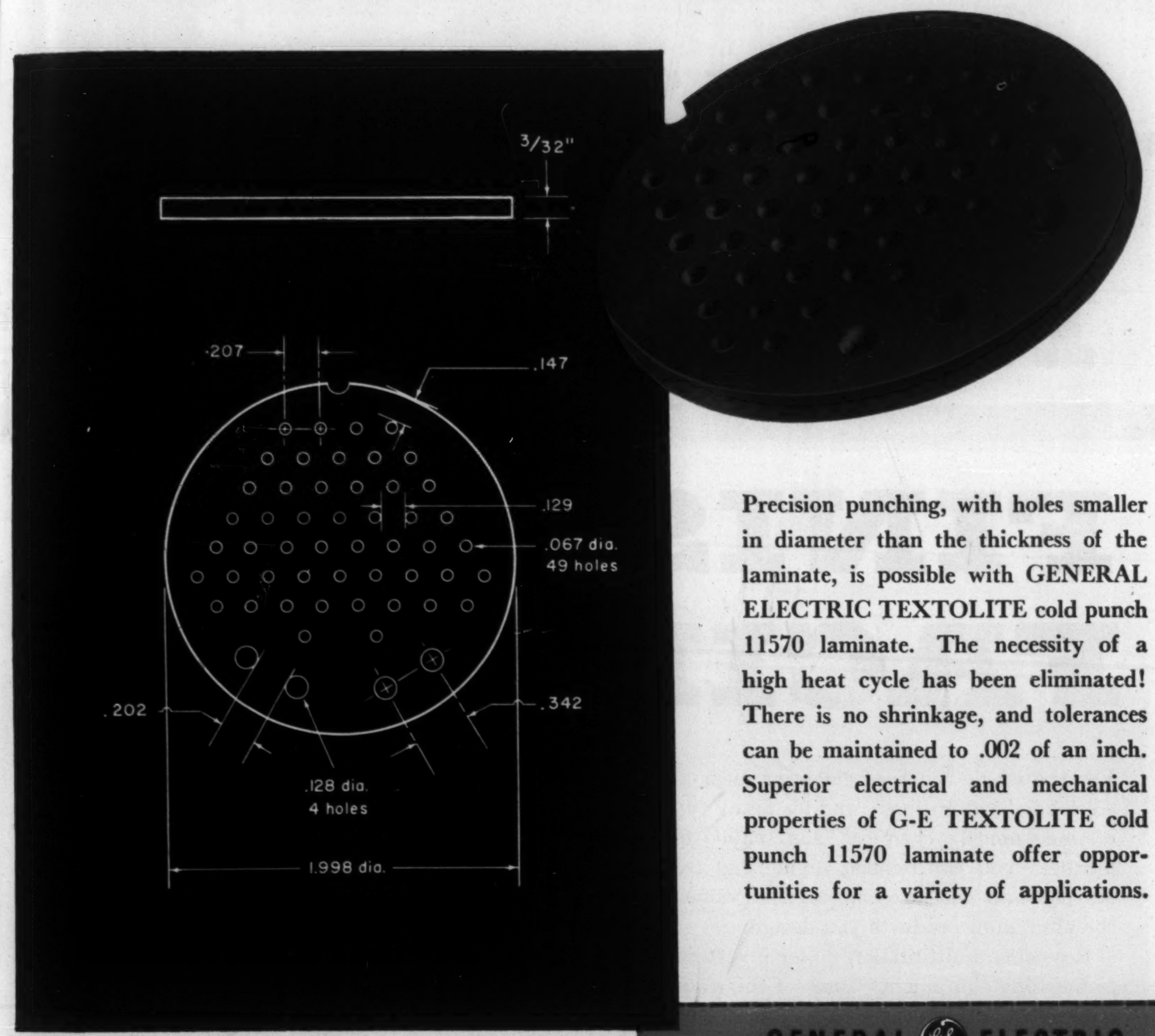
COLD PUNCH 11570 LAMINATE for CLOSE TOLERANCE PUNCHING



Precision punching, with holes smaller in diameter than the thickness of the laminate, is possible with GENERAL ELECTRIC TEXTOLITE cold punch 11570 laminate. The necessity of a high heat cycle has been eliminated! There is no shrinkage, and tolerances can be maintained to .002 of an inch. Superior electrical and mechanical properties of G-E TEXTOLITE cold punch 11570 laminate offer opportunities for a variety of applications.

When the properties have to be right . . .
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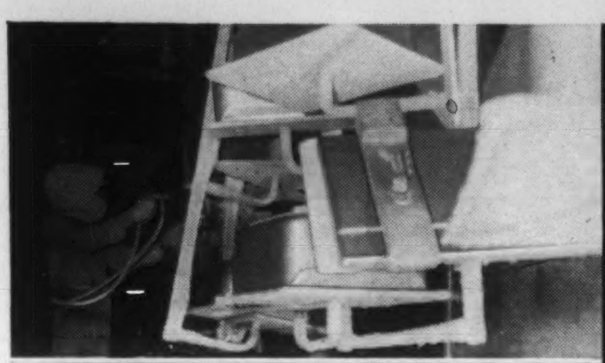
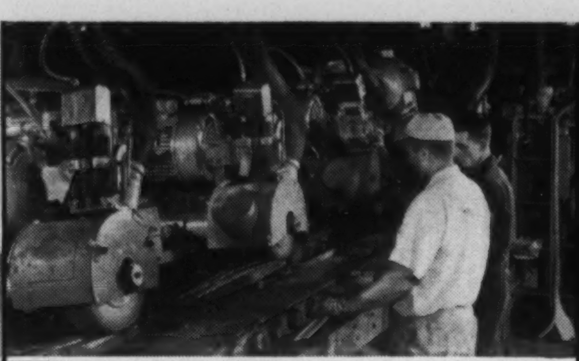


Reynolds can paint entire parts a solid color, mask and paint or do paint filling in combination with mechanical finishing to supply practically any desired texture or highlighting effect.



Part of a battery of new high speed buffing equipment available at Reynolds. Scratch-brushing, satin finishing, highlighting, embossing and other mechanical finishes are also available.

Alodine system at Reynolds is adaptable to immersion, spray or brush type finishing. Etching, brightening and other chemical finish treatments are also available at Reynolds.

for greater design freedom and finer "finished" aluminum products ...use the new, vastly expanded

REYNOLDS

FINISHING FACILITIES

For the magic touch of gleaming clear and color anodized finishes—and for many types of mechanical, chemical and paint film finishes—you can depend on finishes from Reynolds to add sales appeal and value to the aluminum products you design.

Reynolds multi-million dollar investment in finishing equipment—some of this equipment illustrated on these pages—assures you the finest aluminum finishing facilities available anywhere. These recently expanded facilities permit new and greater flexibility in your design thinking. And these facilities are backed by Reynolds years of technical experience with practically every finishing process and technique applicable to aluminum plus Reynolds quality control from mine to finished part.

For full details on the finishing and fabricating facilities available, call the Reynolds Office listed under "Aluminum" in your classified telephone directory or write *Reynolds Aluminum Fabricating Service, 2060 South Ninth Street, Louisville 1, Ky.*

See "CIRCUS BOY", Reynolds new dramatic series, Sundays on NBC-TV

REYNOLDS ALUMINUM FABRICATING SERVICE

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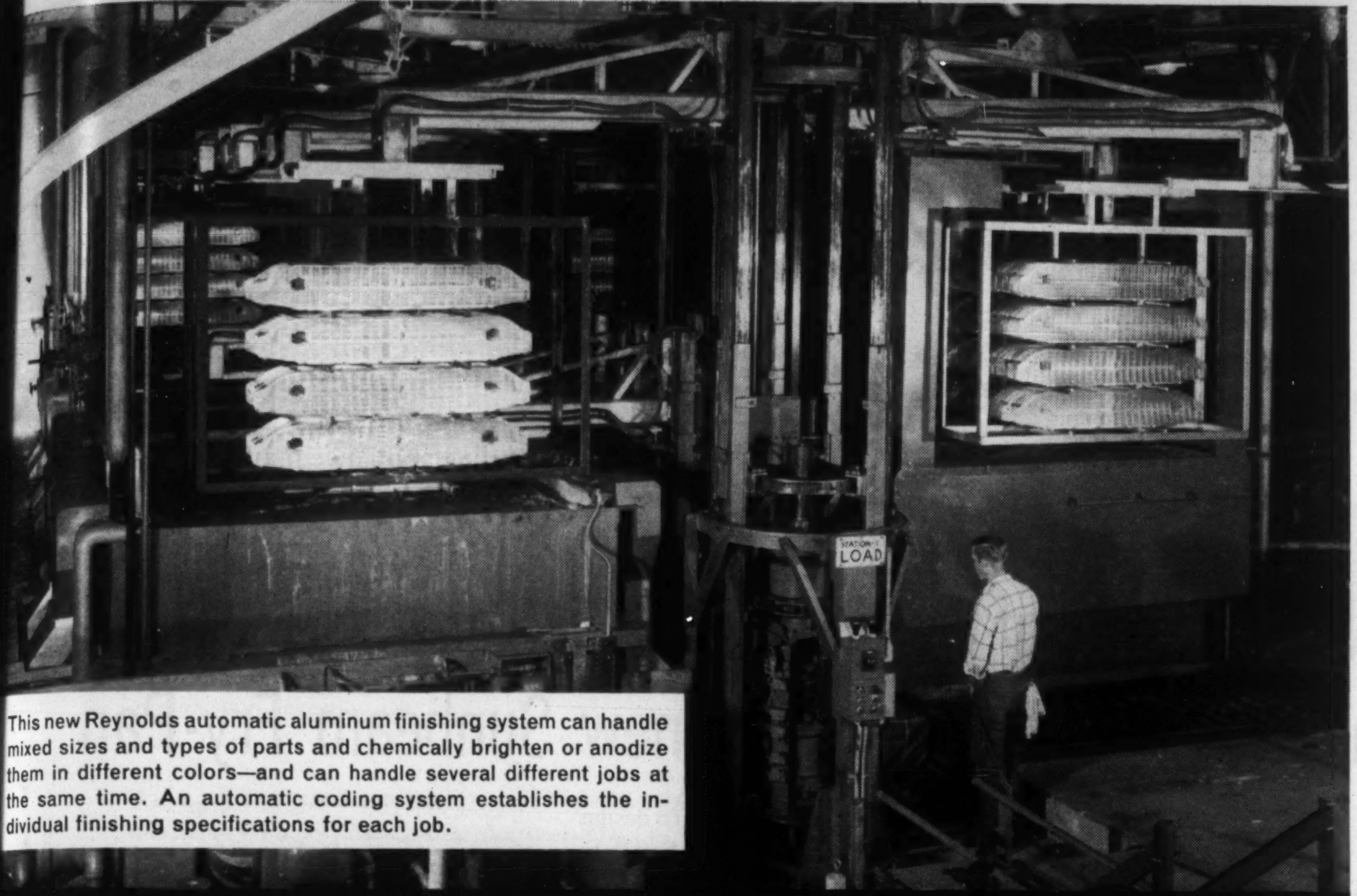
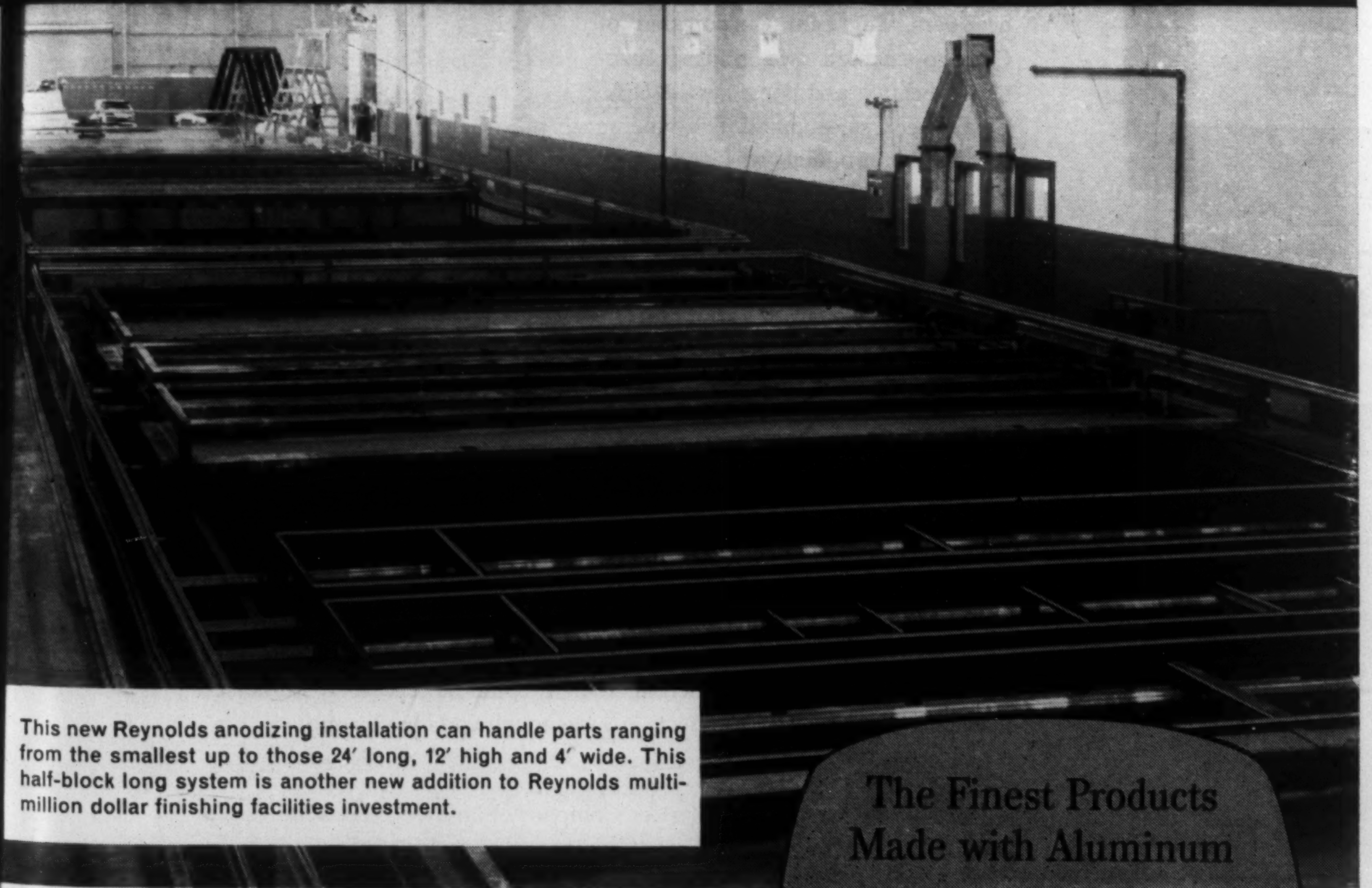


This new Reynolds automatic aluminum finishing system can handle mixed sizes and types of parts and chemically brighten or anodize them in different colors—and can handle several different jobs at the same time. An automatic coding system establishes the individual finishing specifications for each job.



This new Reynolds anodizing installation can handle parts ranging from the smallest up to those 24′ long, 12′ high and 4′ wide. This half-block long system is another new addition to Reynolds multi-million dollar finishing facilities investment.

The Finest Products
Made with Aluminum

are made with

REYNOLDS ALUMINUM

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FINISHING · FORMING · RIVETING

ROLL SHAPING · TUBE BENDING · WELDING

For more information, turn to Reader Service Card, Circle No. 545

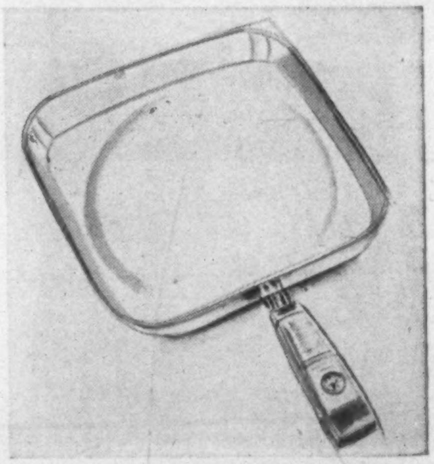
Craftsmanship of the 20th Century

MONSANTO

The speed with which new products pass through the designing stage to final marketing is one of today's industrial phenomena. One factor which has contributed heavily to this is the availability of a wide range of plastic materials with highly usable combinations of properties. And, collaterally, there are the custom molders whose working knowledge and craftsmanship in plastics translate the manufacturer's designs and plans into highly serviceable, highly attractive finished articles. Read how one of America's leading appliance manufacturers collaborated with the custom molder to produce the part that "makes" his new appliance.

New handle of Resinox phenolic plastic houses "the brain" of the new Sunbeam Fry-Pan

DESIGN OBJECTIVES To design the handle for the Sunbeam Fry-Pan, an aluminum frying pan, electrically wired to "do its own cooking." To its designers, Sunbeam Corporation of Chicago stressed two things: functional beauty and long service life. Cost, of course, as on all high-volume competitive products, was also a consideration.



MATERIAL SPECIFICATION In the Fry-Pan, the handle is the "brain"—housing the temperature setting controls, signal light, and automatic regulators that govern the 1150 and 1450 watt tubular element sealed in the base of the pan. Specifications dictated that this handle be inserted into the apertures of the thermostat, then sealed in 3 seconds by a Hannifin hydraulic press. Over 30 exhaustive tests were made to screen different materials in the conditions to which the handle would be subjected in use. Surface finish and hardness, resistance to detergents and boiling water, weight, dielectric strength, and durability were all major factors in determining the material. Monsanto Resinox phenolic plastic was selected. A handle molded of this phenolic had a high natural surface gloss, heat-resistance, and inherent color. It could be repeatedly immersed in boiling water with no ill effects . . . was tough and long lasting.

PRODUCTION Prolon Plastics Company, Florence, Massachusetts, a division of Pro-phy-lac-tic Brush Company, was awarded the job of producing the Fry-Pan handles. In addition to an enviable reputation for high quality molding, Prolon had also demonstrated a productive capacity to meet Sunbeam's production rate. For this handle assignment, Prolon engineers decided on Monsanto Resinox 5797. A free-flowing phenolic molding compound, Resinox 5797 has rapid cure and rigid set, two reasons for its wide use for wiring device parts. It produces parts with a very smooth,

Chief Mold Designer for
Prolon Plastics Co., Mr. Clyde Morrell

hard surface. Equally important, Resinox 5797 meets the critical heat requirements on the Fry-Pan where heat is constantly re-applied to this molded handle. Using Resinox 5797, Prolon molded a handle with a life expectancy far exceeding the required 2000 hours. In fact, if the housewife uses her Sunbeam Fry-Pan with its Resinox handle for 7 hours a week, 52 weeks of the year, she can expect over 5½ years of service under such severe usage.

THE FINISHED PRODUCT The popularity of the Sunbeam automatic Fry-Pan is a tribute to the usefulness of this work-saving kitchen appliance. Practical usefulness has been achieved by following the precepts of functional design and simplicity of form. The jet black lustrous handle of Resinox phenolic plastic adds a high note of functional beauty.

Here is one of the hundreds of design and production problems solved by utilizing the facilities of the plastics custom molding industry. If you are considering a design change or new product, investigate plastics, and the design, engineering, and molding facilities available to you through plastics molders, the Craftsmen of the 20th Century. As a major supplier of plastic resins, Monsanto is in a position to introduce you to custom molders who will put their skills to work for you. Write to Monsanto Chemical Co., Industrial Applications Dept., Springfield 2, Mass.

Investigate Monsanto's complete line of phenolic plastic compounds developed for particular applications and sold under the trade name...

RESINOX®

For more information. Circle No. 493

MONSANTO®

ZENITH
7 TRANSIST

Forticel Cabinet molded for Zenith by Plastic Molded Products Company, Chicago

These are the balanced properties that are giving Forticel its reputation as a "designer's plastic."

TYPICAL PHYSICAL PROPERTIES OF FORTICEL

Flow temperature:		
(°C.) (A.S.T.M.)	D569-48	167—178
Specific gravity	D176-42T	1.18—1.21
Tensile properties:		
Yield (p.s.i.)	D638-52T	3380—5020
Break (p.s.i.)	D638-52T	3470—5240
Elongation (%)	D638-52T	56—66
Flexural properties:		
Flexural strength (p.s.i. at break)	D790-49T	6400—8500
Flexural modulus (10^6 p.s.i.)	D790-49T	0.23—0.30
Rockwell hardness:		
(R scale)	D785-51	62—94
Izod impact:		
(ft. lb./in. notch)	D256-43T	2.7—11.0
Heat distortion:		
(°C.)	D648-45T	59—70
Water absorption:		
% sol. lost	D570-42	0.00—0.08
% moisture gain	D570-42	1.5—1.8
% water absorption	D570-42	1.6—1.8

ZENITH *selects* FORTICEL

new Celanese propionate thermoplastic for its all-transistor portable

The heart of the new Zenith 800 is a remarkable 100% transistor circuit that delivers full room power, tone-true reception.

But what first attracts the eye is its satin-smooth, plastic cabinet—molded of the new Celanese thermoplastic Forticel.

Forticel was created and engineered for just such demanding applications . . . places where beauty and precision are twin specifications . . . where Forticel's qualities of moldability, superb surface finish, high impact strength, form retention and freedom from objectionable odor can contribute to ready consumer approval as well as manufacturing efficiencies.

We urge you to inspect the new Zenith 800 at your favorite radio shop, and see one of the most skillfully engineered circuits in Zenith history . . . and one of the most carefully engineered thermoplastics in service today. You will understand why Forticel has been welcomed by the molder and designer, and why it is being specified for an increasing number of famous name products.

Send for Product Bulletin NP-16. Use coupon below.

Celanese Corporation of America, Plastics Division
Dept. 102-L, 290 Ferry Street, Newark 5, N. J.

Send me New Product Bulletin NP-16 on Forticel Plastic.

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Celanese
plastics

Celanese® Forticel®

For more information, turn to Reader Service Card, Circle No. 496

HIDDEN flaws in your products need detecting?

Every day brings new inspection problems to Picker for possible solution. More often than not, radiography (or fluoroscopy) can help. *Here's a typical week's score . . .*

PROBLEM	SOLVED
glass splinters in some candy bars	✓
solder invasion of a precision resistor	✓
bubbles in glass containers	✗ difficult
poor bond in ceramic insulators	✓
failures in adhesives	✓
knives in crude rubber "biscuits"	? maybe
stringers in a highly-stressed lock nut	✓
clearances in a miniaturized amplifier	✓
solder tinning on a thin connecting lug	no ✗
porosities in a new type of false tooth	✓
welds in bandsaw blades	✓

Makes no difference *what* you make or buy or sell . . . if it needs "seeing into" for quality control, radiography (gamma or x-ray) can probably profit you.

Talk it over with your local Picker representative * or write us outlining your problem and, if possible, sending typical samples. We'll make tests and tell you frankly whether radiography holds any promise for you. **Costs you *nothing* to find out . . . maybe it's costing you a great deal right now NOT TO.**

*** There's probably a Picker district office near you (see local 'phone book).***

Picker x-ray

PICKER X-RAY CORPORATION
25 South Broadway, White Plains, N. Y.

Picker... your one Source for Everything in Radiography and Fluoroscopy

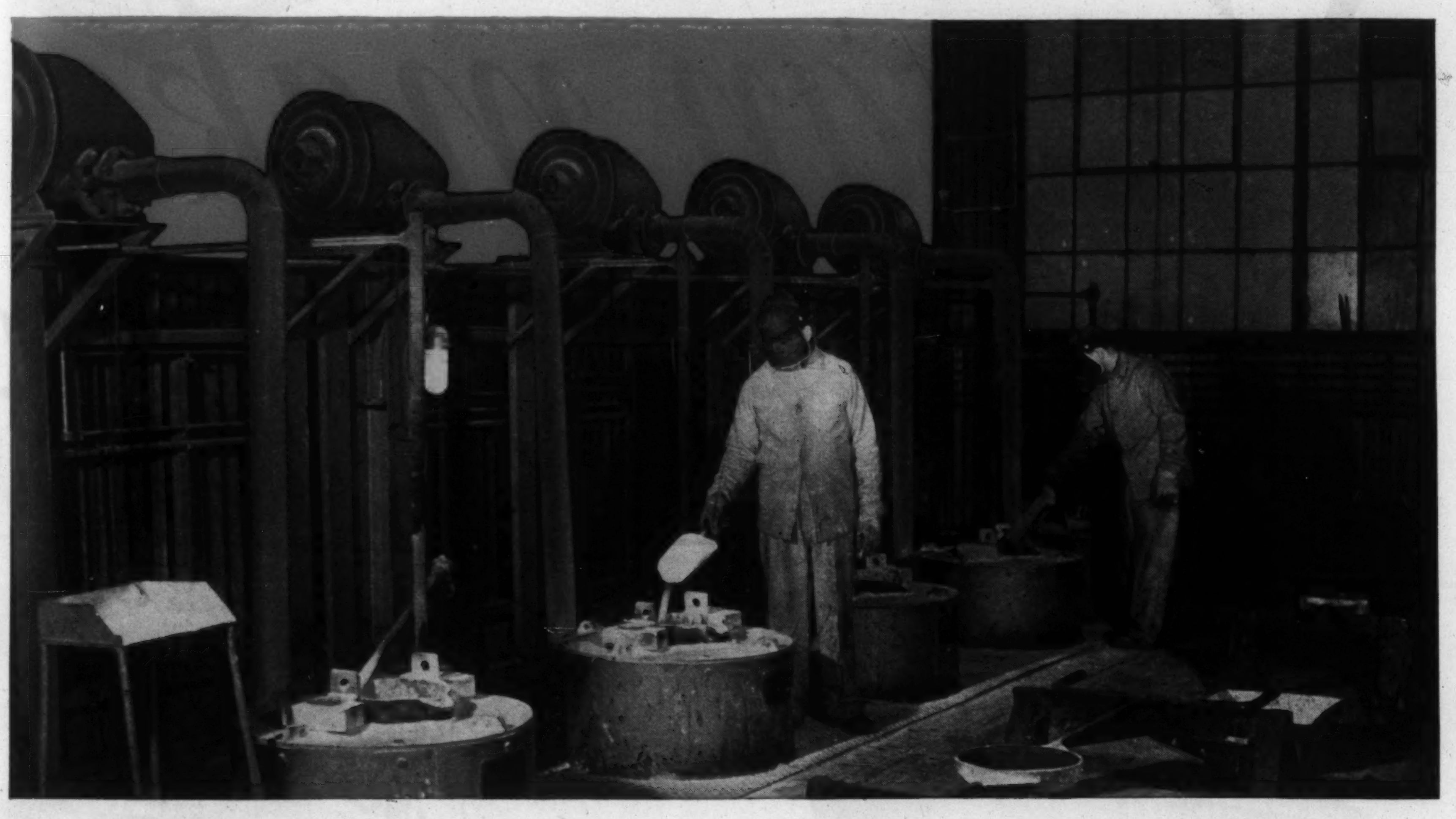
For more information, turn to Reader Service Card, Circle No. 495

Nonferrous Melting with . . .

SPENCER
HARTFORD

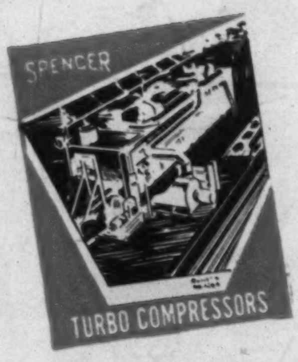
TURBO-COMPRESSORS

There are many methods of melting non-ferrous metals but the accepted standard for furnishing air to Oil and Gas fired furnaces is the Spencer Turbo-Compressor. A battery of Spencer 5 HP turbos in the foundry of a large Chemical plant is shown below.



Thirty-five years ago the Spencer Turbo was first specified by a furnace manufacturer. Today it is the first choice of all of the leading furnace and oven manufacturers.

The reasons they prefer Spencer are the absolute reliability—perfect performance and low maintenance over long years of almost continuous service. Spencer Turbos range in size from 35 to 20,000 cu. ft. per min., 4 oz. to 10 lbs. and 1/3 to 1,000 HP.



For complete description of the standard and special Turbos ask for Bulletin No. 126-A.

THE SPENCER TURBINE COMPANY

SPENCER
HARTFORD

HARTFORD 6
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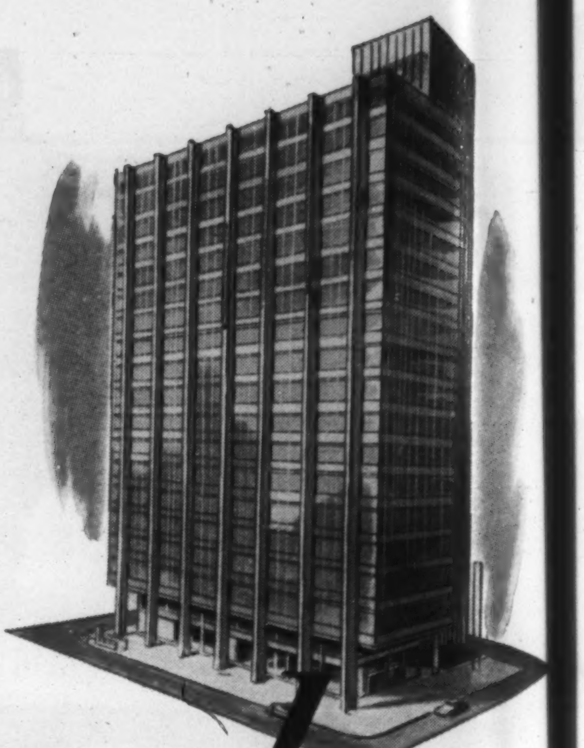
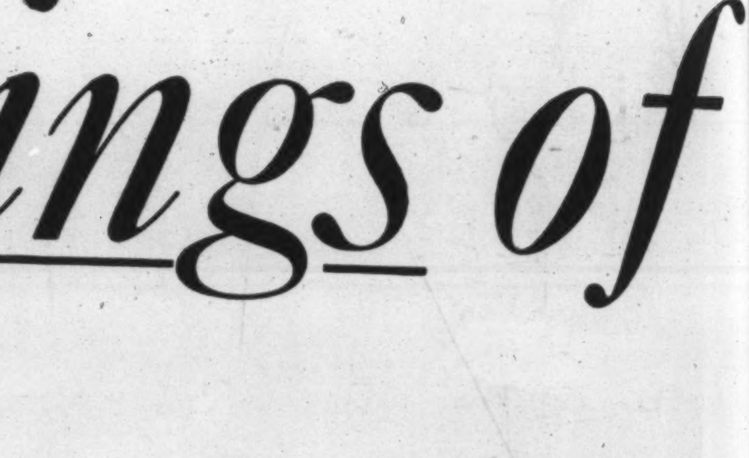
494-N

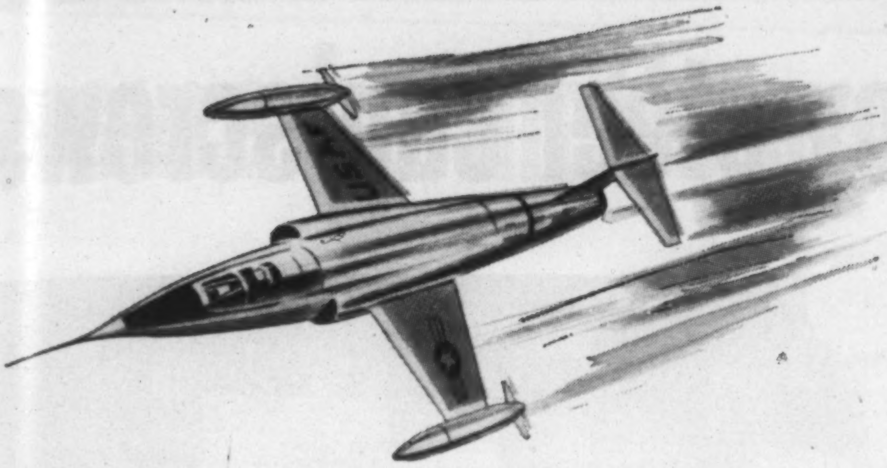
Manufacturers of Turbo-Compressors and Heavy Duty Vacuum Cleaners

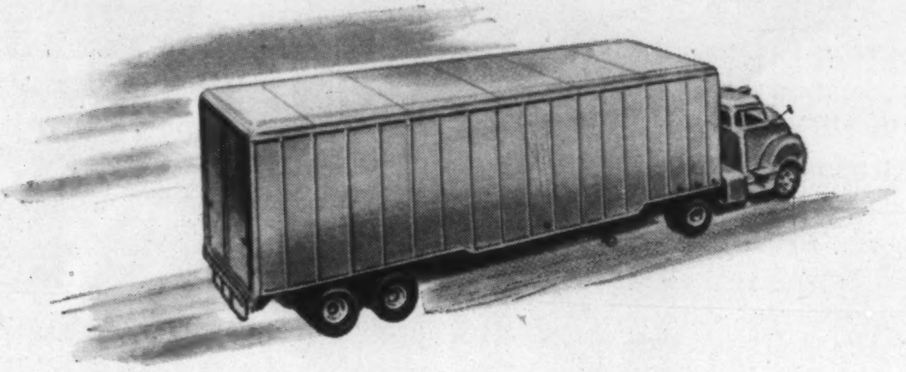
For more information, turn to Reader Service Card, Circle No. 443



Now...
You can make more things of







f Stainless Steel

The new "200" Series Stainless Steels successfully ease nickel shortage!

With the new low-nickel "200" Series Stainless Steels, producers can greatly expand their output of Chrome-Nickel stainless from existing nickel supplies. These steels provide practical, workable grades of stainless that can be applied to a wide variety of uses.

Made of Chromium-Nickel-Manganese—the "200" Series steels are helping to meet constantly growing needs in transportation, building, manufacturing and many other fields. They're becoming increasingly popular in kitchen utensils, appliances, truck bodies, trains, automobile trim, and scores of products for industrial, home and business use. For further information, see your stainless steel supplier, or write Electromet—leading producer of more than 100 alloys, including chromium and manganese, for the steel and non-ferrous metal industries.

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A Division of Union Carbide and Carbon Corporation
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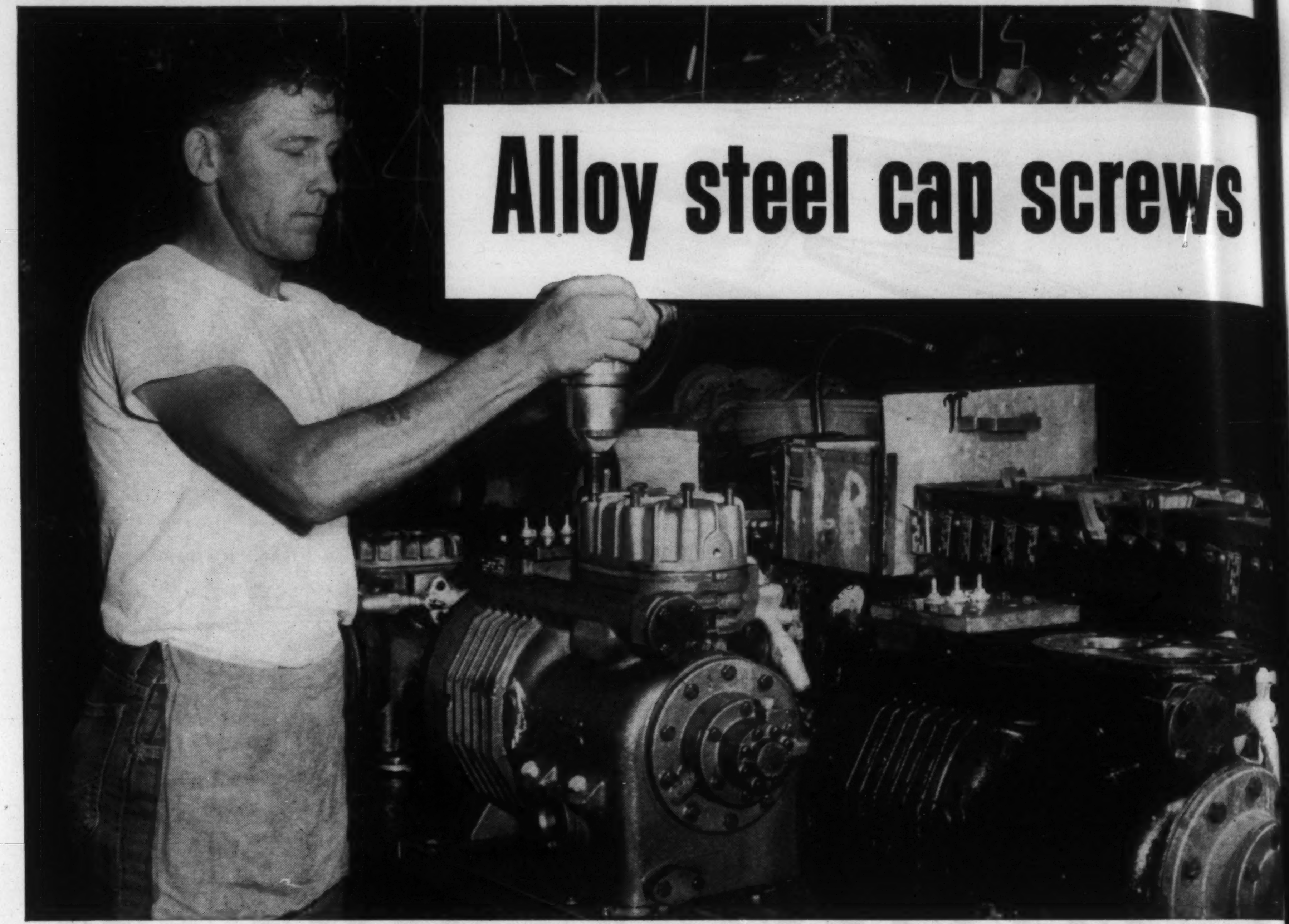
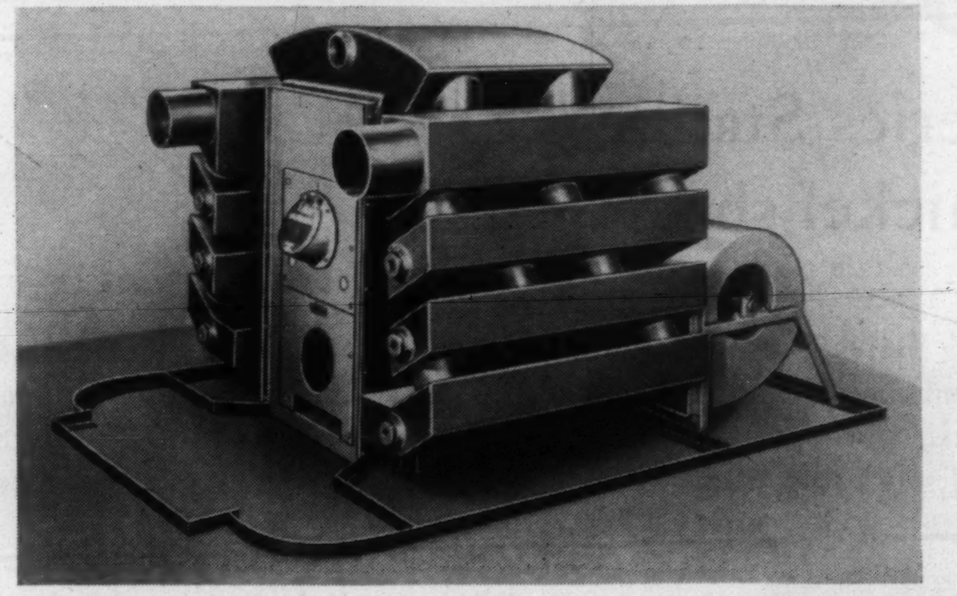


Alloy steel cap screws as



SAFE, GAS-TIGHT JOINTS required by the down-flow construction of this year-round furnace and air-conditioning unit are easy to obtain, using Republic ELECTRUNITE® Mechanical Tubing. Its uniform roundness, wall thickness, strength and ductility help simplify design and fabrication. Quality control from raw ore to finished product assures long, trouble-free service.

REPUBLIC

REPUBLIC STEEL ®

World's Widest Range of Standard Steels

assure hermetic seal permanence

One of the most critical points in maintaining an absolute hermetic seal in any refrigeration system is the joint between compressor cylinder and head. That's why Copeland Refrigeration Corporation of Sidney, Ohio, manufacturer of fine commercial refrigeration and air conditioning compressors, insists on cylinder head cap screws made to exacting specifications. Republic Alloy Steel Hex Head Cap Screws fill the bill perfectly. They more than meet tensile strength, yield point, hardness and ductility requirements.

Design of the Copeland Compressor calls for cap screws to clamp cylinder head, a neoprene gasket, valve plate, another neoprene gasket and cylinder block into one solid, leakproof assembly. Year-in, year-out service dependability demands that these fasteners neither stretch nor lose their grip under the heating and cooling cycle of on-off operation. There must be no loss in compression or escape of refrigerant. Again, Republic Alloy Cap Screws are more than equal to the task—as proved by their failure-free performance record.

Whatever your fastener problem, it will pay you to check Republic. 20,000 standard and 8,000 special types and sizes of headed and threaded products are available to satisfy a tremendous variety of applications. Each is backed by a century of experience, and quality controlled from raw ore to finished product.

You can get complete information through your local Republic office. Or simply mail the coupon.

OUTSTANDING PRODUCT PERFORMANCE is assured when you specify Republic Hot Rolled Carbon or Alloy Bars as your raw material. A full range of standard and special shapes, sizes and grades is available to meet the most exacting requirements. Further, Republic's 3-Dimension Metallurgical Service can help you select the proper type, and process it efficiently.

ZINC COATING PERMANENCE makes Republic Continuous Galvanized Sheet ideal for hundreds of mass-produced parts and products. Its uniform, corrosion-resistant zinc coating will not crack, flake or peel under any forming operations permitted by the base metal. Resulting product is far less expensive to produce than old-fashioned, hot-dipping after fabrication would allow. Send coupon for information.

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it's NEW...
it's WIDE...
it's BRIGHT

MicroRold®
STAINLESS SHEET

Type 430 Bright Finish

up to 48" WIDE

BRIGHTER THAN EVER!—MicroRold stainless steel Type 430 in the NEW Bright Finish is now immediately available in sheets up to 48" wide offering new usefulness and economy in stainless fabrication. Produced with the same micro-accuracy of gauge for which MicroRold 36" is well known, Type 430 Bright up to 48" wide gives greater latitude in applications for quality stainless steel.

MicroRold 430 is also available in the regular commercial finishes and MicroRold stainless in other grades are now produced up to 48" wide. Complete details sent on request.

12-F

Washington Steel
Corporation
WOODLAND AVENUE WASHINGTON, PA.

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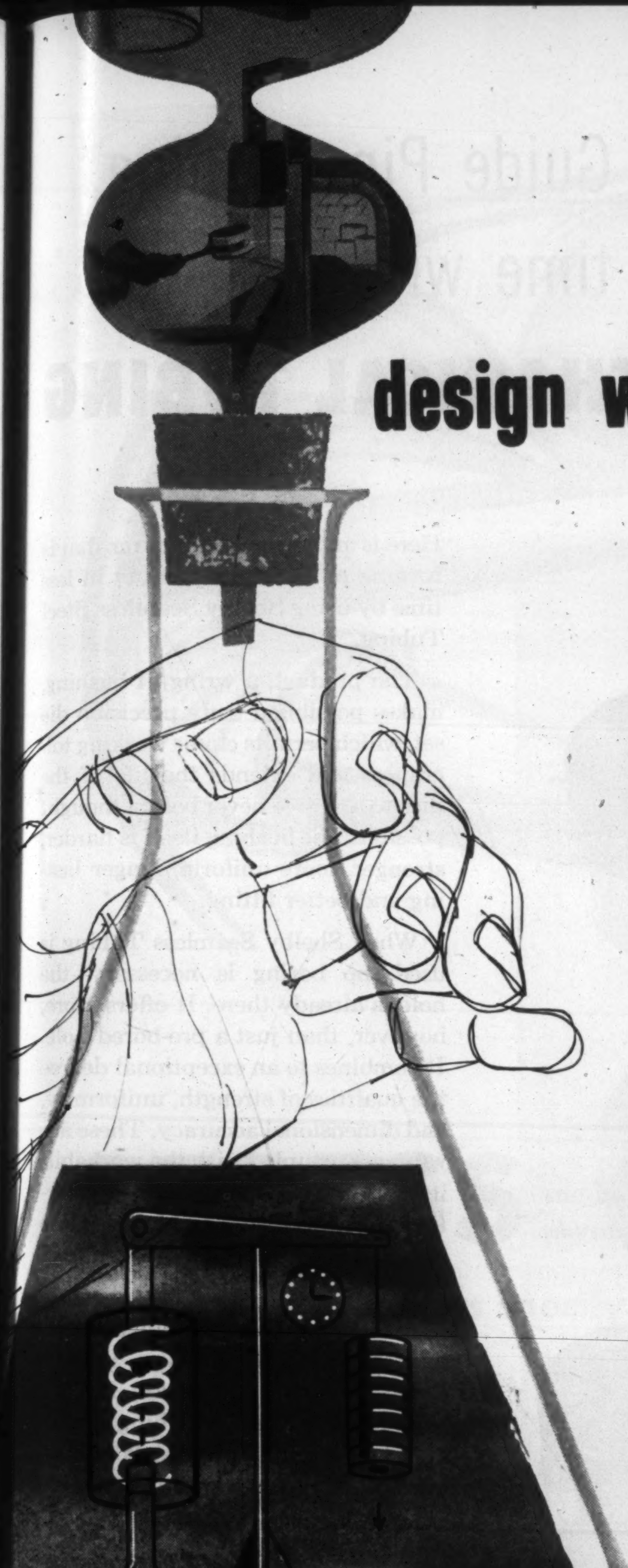
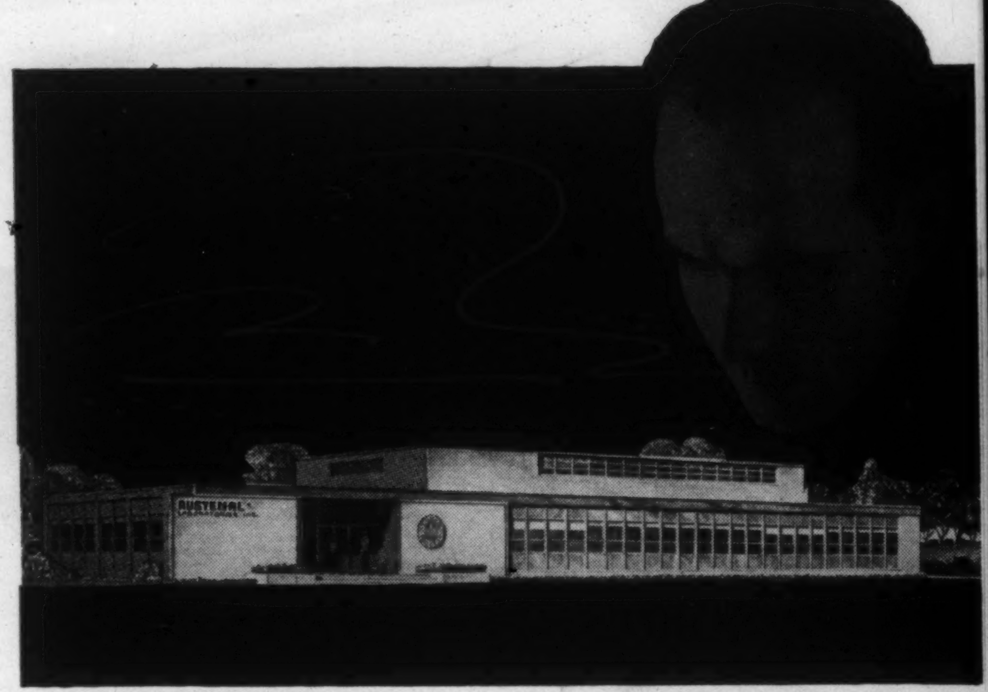


design with **austenal** in mind



New **microcast** *Research Facilities will increase investment casting applications and give design engineers greater latitude in planning parts.*

A new facility for advanced research is now under construction at Austenal to broaden the many applications of Microcast—to make new methods and alloys available, and to allow greater freedom and latitude in part designing.

One section of this new plant will contain the equipment familiar to the investment casting industry and in addition, equipment necessary for investigating numerous other methods of making and treating castings. Adjoining the foundry area will be shops for pilot line and experimental work in mold making, waxing, investing and finishing. There will be an area containing laboratories for mechanical testing, physical testing, metallographic investigations, refractories development and chemical investigations.

Contact your Austenal engineer today and ask him to show you how Austenal's continuing program of research and development will help you design greater performance and reliability into the investment castings you require.

For more information, turn to Reader Service Card, Circle No. 540

- - - *It's* **NEW** *from Austenal*

"Design with Microcast in Mind," Austenal's new informative booklet, tells you how to get the greatest benefit from Microcast, showing the great latitude of design possibilities, alloys available and a great deal more, valuable information. Write for it today.

design
with microcast
in mind

PRECISION CASTINGS

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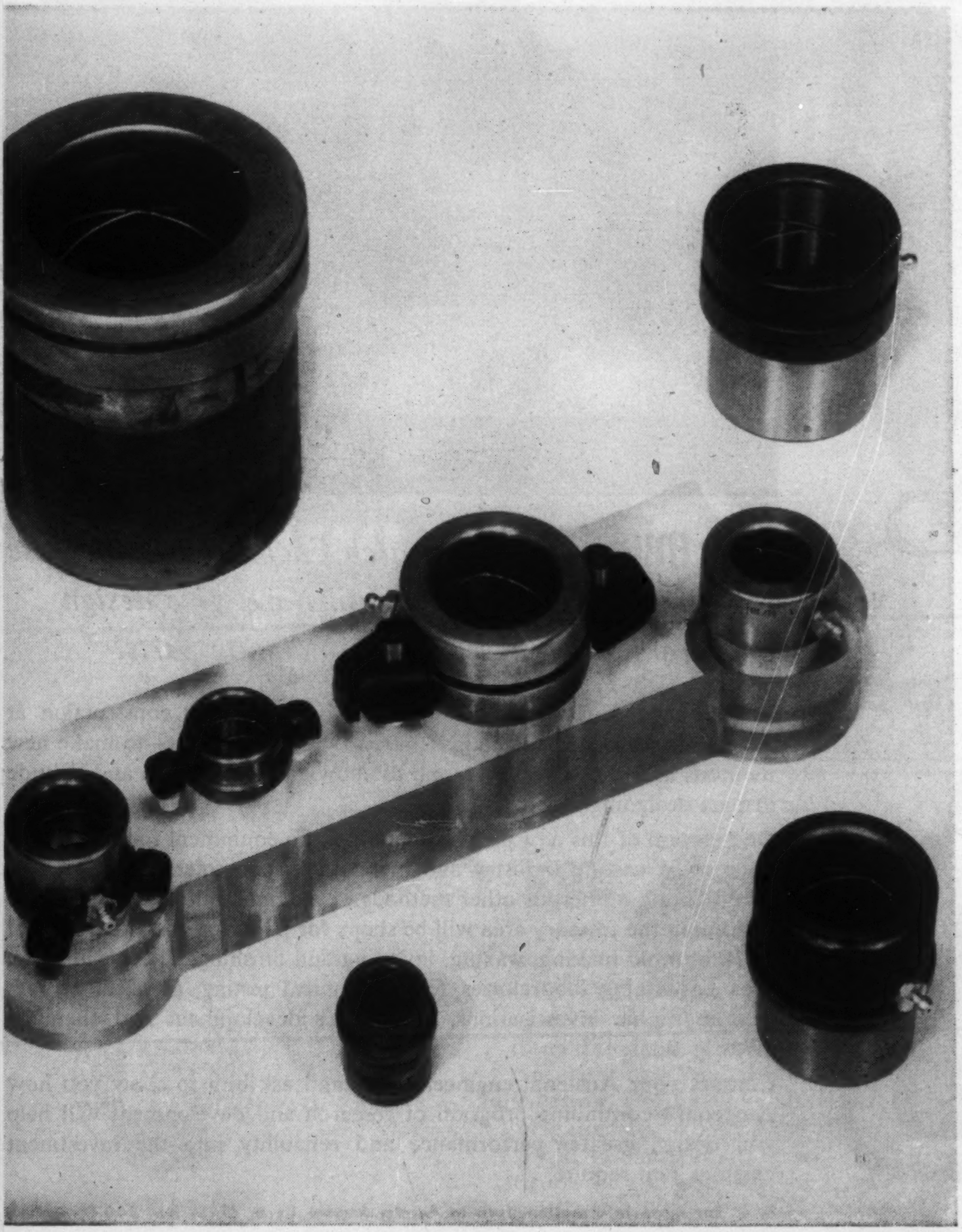
How a better precision-fit Guide Pin Bushing* is made in less time with

SHELBY SEAMLESS MECHANICAL TUBING



Here is another manufacturer that is turning out a better product in less time by using Shelby Seamless Steel Tubing.

The product, a wring-fit bushing, makes possible a truly precision die set, which permits closer working tolerances and extends the life of the dies to a degree never before thought possible. The bushing itself is harder, stronger, more uniform, longer lasting and better fitting.

When Shelby Seamless Tubing is used, no boring is necessary—the hole is already there. It offers more, however, than just a pre-bored hole. It combines to an exceptional degree the qualities of strength, uniformity, and dimensional accuracy. These advantages, coupled with the workability and excellent machining properties of Shelby Seamless, make it the ideal material for critical mechanical applications like this.

Available in a wide range of diameters, wall thicknesses, various shapes and steel analyses, Shelby Seamless Mechanical Tubing is produced to exacting standards by the world's largest manufacturer of tubular steel products. Get in touch with our engineers if you would like help in applying Shelby Seamless to your specifications.

**Manufacturer's name on request.*

NATIONAL TUBE DIVISION, UNITED STATES STEEL CORPORATION, PITTSBURGH, PA.
(Tubing Specialties)
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS SHELBY SEAMLESS MECHANICAL TUBING

UNITED STATES STEEL

STRESS

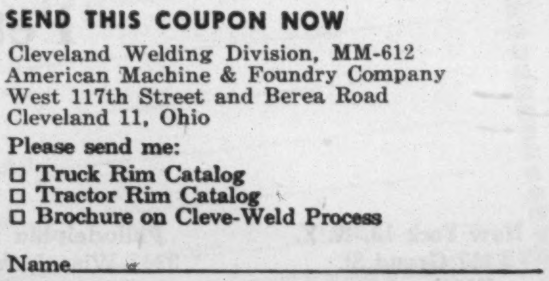
can be a hidden enemy of circular parts like jet-engine rings. To insure physical and metallurgical accuracy, specify Cleve-Weld welded rings.

Top Jet-Engine makers specify Cleve-Weld rings

The *design, metallurgy* and *production* of welded circular parts have been Cleve-Weld specialties for 45 years. We've worked with materials from carbon to stainless and the latest aircraft alloy steels. Cleve-Weld has the specialized equipment and experience to do exacting jobs. These are the reasons why America's jet-engine makers procure Cleve-Weld rings. Pratt & Whitney J-57, Wright Aeronautical J-65, General Electric J-47 and other great jet engines testify to our ring accuracy.

Cleve-Weld is also a prime supplier of truck and tractor rims, rings, bands and gear blanks. *Make Cleve-Weld your primary source for all rolled and welded circular parts, too.* We'll show you why in dollars and cents. Write Circular Welded Products Sales Department below.

THIS IS THE BASIC CLEVE-WELD PROCESS. Rectangular bars or special contoured sections of steel are rolled into a circular form. Next, the part is welded and then expanded into a true circle. This tests the weld and insures accuracy. Later operations add stress relief and desired hardness.



EXAMPLES OF CLEVE-WELD PROCESS PRODUCTS

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CLEVELAND WELDING DIVISION
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Quality, too — is something you can depend on from Frasse. Time-tested Reynolds Aluminum—processed to exacting tolerances with completely uniform characteristics — can help your production picture and the salability of your product.

Frasse aluminum stocks include a complete range of sizes in *all* of the popular shapes, grades and tempers—and Frasse engineers will be glad to assist with grade selection and methods of fabrication. Call your nearest Frasse office when you next need aluminum. You'll like the smooth efficiency and speedy delivery that helps you get the job done . . . faster.

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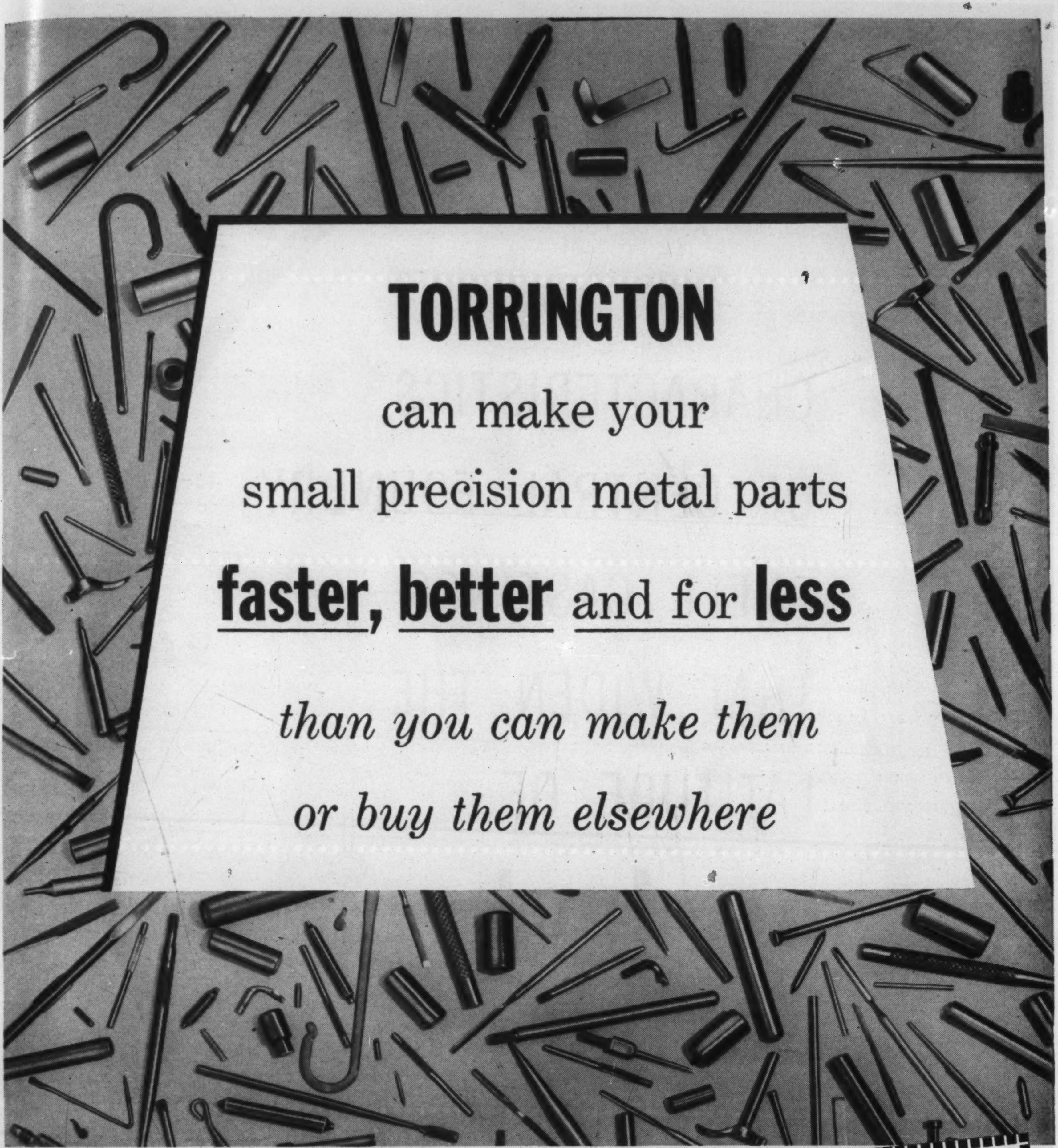

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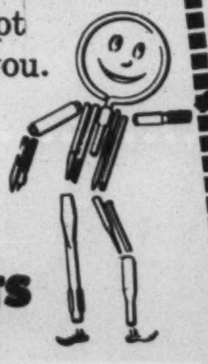
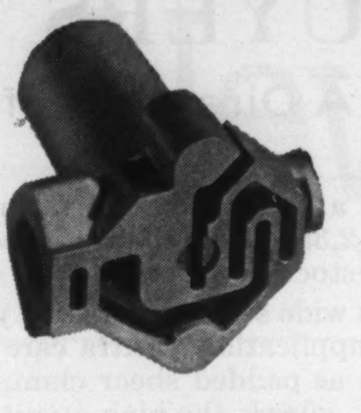
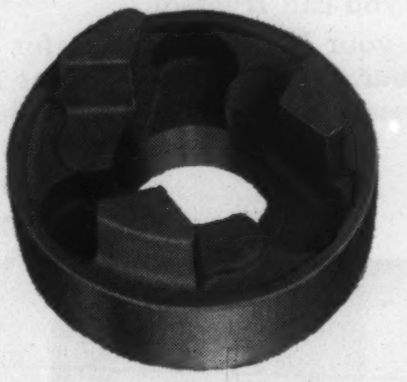


CHARACTERISTICS
OF CENTRAL FOUNDRY
SHELL CASTINGS
THAT WIDEN THE
LATITUDE OF
product
design

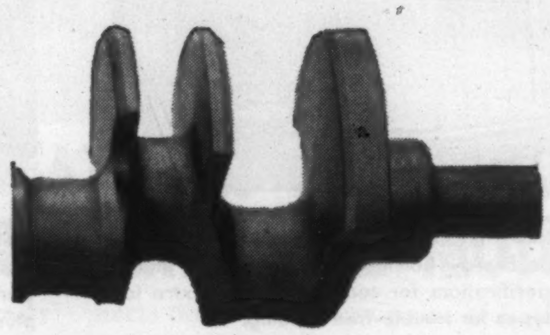
intricate designs which are not practical with sand-castings, can frequently be produced in volume by the CENTRAL FOUNDRY SHELL MOLD PROCESS. Deep pockets can be drawn with a minimum of pattern draft. Pieces can be cast which have grooves and recesses without the need of additional cores, and the relationship of holes to the body portion can be maintained. The governor body is an example of this characteristic of shell castings.



closer tolerances can be held with shell castings than with green sand castings. The transmission drum is a typical example of a piece that gained by being held to very close dimensions. This factor can affect product design by making it possible to take advantage of the strength of alloy grey iron or ArmaSteel in a piece that might otherwise have to be die-cast in a soft metal.



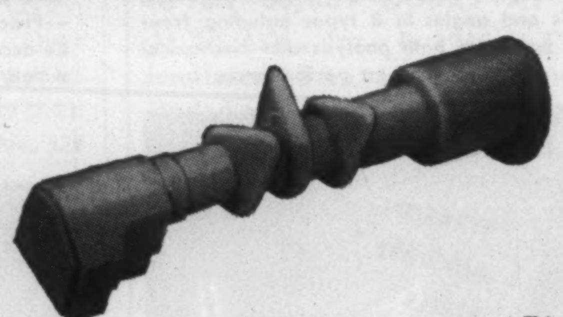
the better dimensional control of shell castings makes it possible to substantially alter the design of a piece. Narrow spaces between counterweights in a crankshaft, for example, can be produced that are impossible in a forging.



smoother surfaces • Shell casting permits excellent duplication of surface detail. The engineer designing a piece that should possess high strength, but also some detail as to surface (such as cast-in lettering) may now find the answer in a shell casting.

shell coring produces more accurate internal surfaces. Because shell cores are cured in the corebox, intricate shapes are possible.

So many characteristics of CENTRAL FOUNDRY shell castings permit improvement in design, in material and in net cost that design engineers in many industries are specifically recommending these castings of grey iron, malleable iron or ArmaSteel. For further engineering data write for new 36-page shell casting manual . . . just completed.



74

CENTRAL FOUNDRY DIVISION

GENERAL MOTORS CORPORATION • SAGINAW, MICHIGAN • DEPT. 16

For more information, turn to Reader Service Card, Circle No. 476

BUYERS GUIDE TO STAINLESS

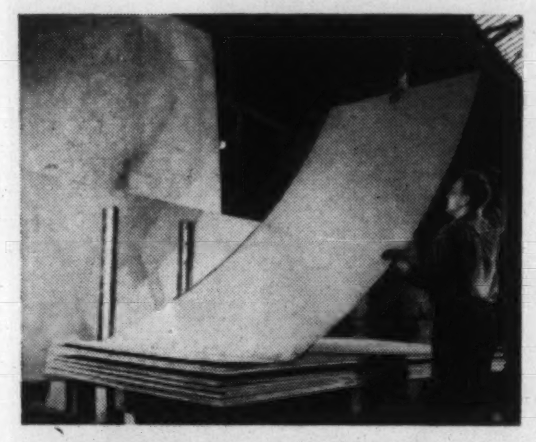
A Directory of Ryerson Stainless Steels and Services

Here's a quick guide to the nation's largest stocks of stainless steel—2,351 sizes, shapes, types and finishes of Allegheny stainless in stock at Ryerson.

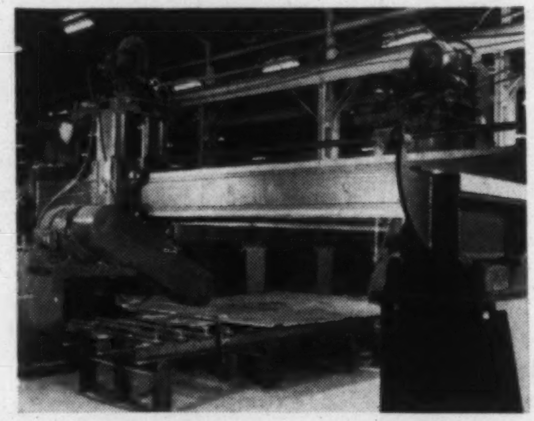
This wide selection assures you of getting the best stainless for every application. Extra care in storage, handling and shipping —such as padded shear clamps to protect finish and flatness of sheets—guards the high quality of Ryerson stainless stocks. And in addition, the help of full-time stainless specialists is yours when you call Ryerson.

See your Ryerson catalog for a complete listing of stocks and call your nearby Ryerson plant for quick shipment of Allegheny stainless—one piece or a truckload.

SHEETS—11 analyses of Allegheny stainless sheets in stock including nickel and straight chrome types. Also extra wide sheets to reduce welding costs.

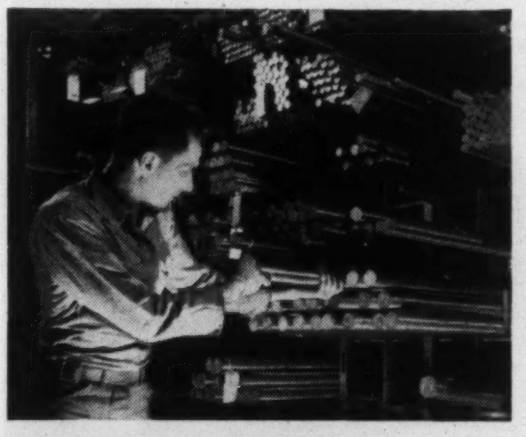


PLATES—Available in 9 analyses including plates to Atomic Energy Commission requirements and to ASTM specifications for code work. Also extra low carbon types for trouble-free welding.



TRUE-SQUARE DISC CUTTING—Stainless plates up to 12′ x 25′ cut absolutely square on abrasive disc machine. Length and width tolerance plus or minus 1/32″.

A NEW STEEL—Type 202 Allegheny Stainless is available in 14 to 26 gauge sheets. Type 202 compares favorably with 302 in corrosion resistance; costs 2¼¢ per lb. less.



BARS AND ANGLES—Rounds, squares, flats, hex's and angles in 8 types including free-machining bars with both analysis and mechanical properties controlled for best performance.

CIRCLES, RINGS, SPECIAL SHAPES—Practically any shape, no matter how intricate, can be accurately flame cut from stainless steel plate by skilled Ryerson operators.

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DOW CORNING
CORPORATION

Silicone News

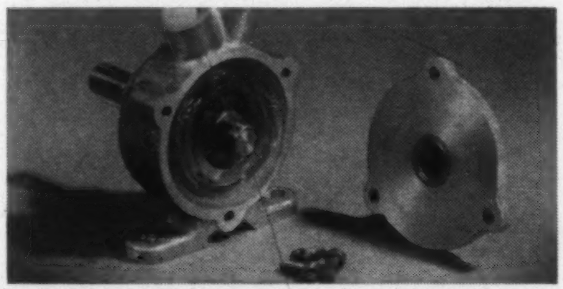
FOR DESIGN ENGINEERS No. 33

Pump Life Tripled with Silicone Lubricant for Plastic and Rubber

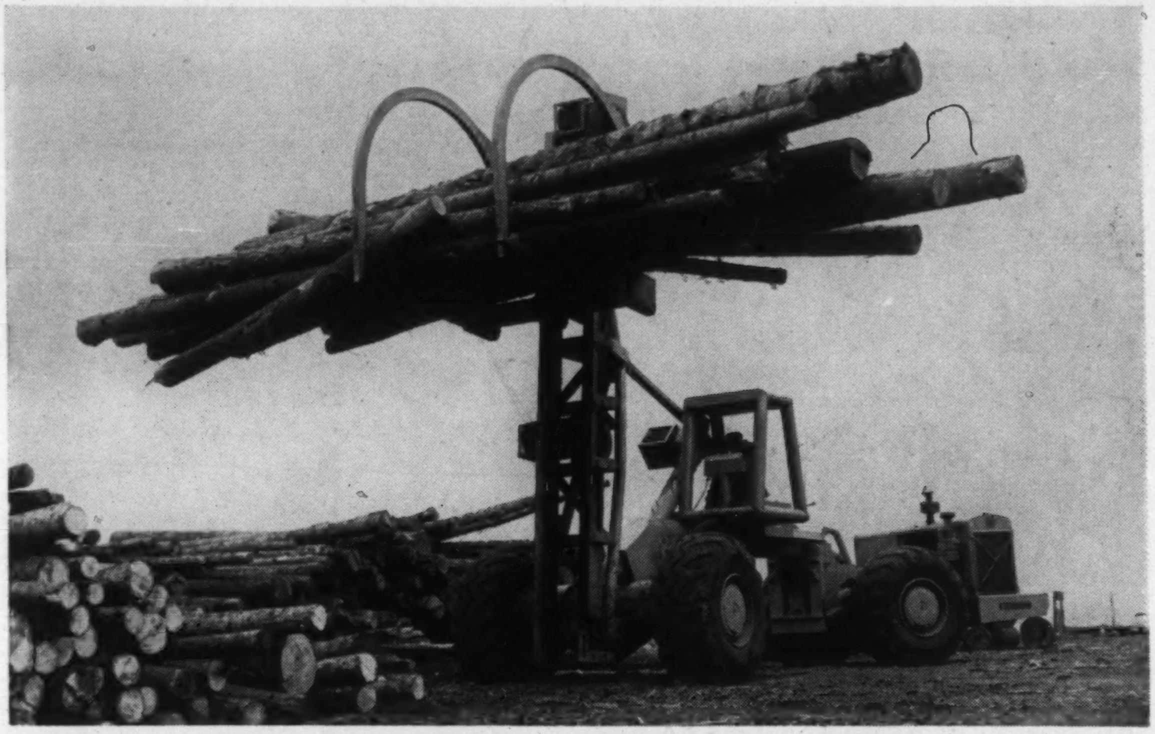
Chemically inert Dow Corning 3 Compound provides outstanding lubrication for moving plastic or rubber parts. Proof of its efficiency is provided by the Becher Pump Company, Chicago, Illinois.

Becher produces a positive-flow chemical pump incorporating a nylon planetary roller plus a vinyl guard and tube. The pump is designed to carry chemical slurries, liquids or gases without danger of contamination or reaction.

By sealing the pump with Dow Corning 3, thus lubricating both plastic parts and sleeve bearing, Becher engineers tripled the unit's service life while reducing power requirements by 50%. They further report that introduction of the silicone compound so drastically reduced starting torque that they now employ a 1/25 hp, 1720 rpm shaded pole motor to do the work that previously required a more costly 1/12 hp split phase motor.



(*Cont. Pg. 2*)



GIANT LOG STACKER ATTAINS GARGANTUAN POWER WITH SILICONE INSULATED MOTORS

Engineers designing large electrically powered equipment are attaining more power per pound while gaining the many advantages of placing the power unit closer to the work by using motors insulated with Dow Corning Silicones. An excellent example is the giant Electric Log Stacker produced by R. G. LeTourneau, Inc., Longview, Texas.

A separate high torque, a/c motor connects directly to every point of load — lift fork, hold-down tusks, boom tilt and rear axle steering. And there is a separate d/c motor inside each of the four rubber-tired drive wheels. A diesel-generator set supplies power to any or all motors on demand.

The work potential of these mechanical giants is worthy of Paul Bunyan. A single bite of the lift forks conveys up to 25 tons of logs; one stacker can move more logs

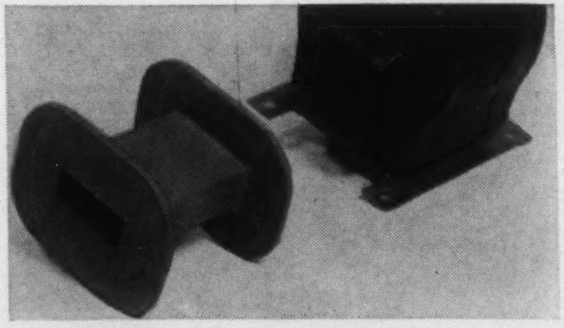
(*Cont. Pg. 2*)

Coil Bobbins of Silastic Resist Unusually High Voltage, Temperature

Combine high temperatures and high voltage and you'll quickly expose any weak link in an electrical insulation system. That's what happened when technicians at Transformer Engineers, Pasadena, California, tested conventional choke coils intended for use on aircraft fire control apparatus.

The tests revealed that conventional coil bobbins all too often developed "electrical punctures" in the tube-to-flange joints when subjected to 15,000 volts at 140 C (320 F) operating temperatures.

The problem was overcome, however, with bobbins molded in one piece of Silastic, the Dow Corning silicone rubber. Featuring excellent thermal stability and dielectric strength after prolonged exposure to high temperatures, their one-piece construction avoided tube-to-flange joints entirely. Over 3000 of them have been put into service in the last two years; not one failure has been reported to date. ***No. 329***



CLASS H MOTOR STILL ON TEST AFTER 60,039 HOURS AT 240 C

At 10 A.M., June 6, 1946, a Class H insulated 10 hp motor was generator loaded to operate at its test temperature of 240 C in Dow Corning's motor test labs. Every 500 hours since it has been shut down and exposed to 100% relative humidity for 24 hours. As of 11 A. M. October 1, 1956, this motor was still on test after 60,039 hours at an average copper temperature of 240 C! That's equivalent to 367 years operation at the Class H temperature of 180 C.

FOR DATA RELATING TO THESE ARTICLES, CIRCLE REFERENCE NUMBER IN COUPON ON NEXT PAGE

MORE

DOW CORNING
CORPORATION

Silicone News

DOW CORNING PUBLICATIONS ON NEW DEVELOPMENTS AND TECHNICAL DATA . . . .

Parts fabricated of Silastic are now available from over 150 companies listed in recently revised reference. Conveniently located in or near most industrial areas, these companies are equipped to fabricate Silastic parts to meet every requirement, including coated fabric, ducting and hose, extrusions, gaskets and seals, molded parts, O-rings, rollers, specialty and sponged parts, wire and cable. ***No. 334***

●

Documentary film "What's a Silicone?" available free of charge for showing to technical audiences. For more information circle ***No. 335***

●

Primers and Adhesives for Silastic are listed in a compact reference sheet that compares methods of application and recommended cure times, all in easy-to-read tabular form. A handy and valuable aid to designers and engineers in selecting the product best suited for a particular application. ***No. 336***

●

"Silicone Insulated Conductors," a reprint from WIRE AND WIRE PRODUCTS, describes and compares eight different types of silicone insulated wire and cable currently available for different applications. ***No. 337***

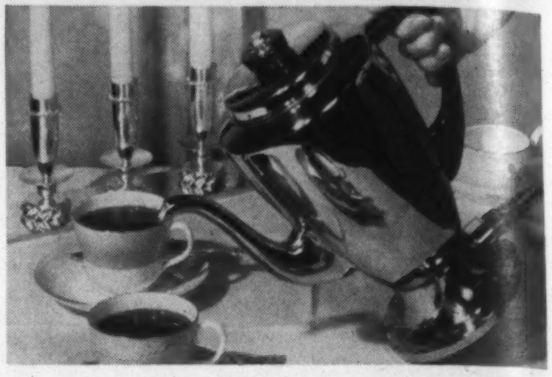
●

Dow Corning Silicone Lubricants, including oils and greases, are described in a new, illustrated 8-page brochure that gives their properties, lists typical applications, and cites factors which contribute to obtaining longer life. ***No. 338***

●

All New — 1957 Guide to Dow Corning Silicones is a twelve page, fact-filled catalog which briefly describes the silicone products of interest to most industries. Containing latest data and information, the guide is designed expressly to help you enjoy the advantages, profits, and savings made possible through imaginative use of these unique engineering materials. ***No. 339***

Improve Percolator With Silicone Laminate At No Extra Cost



Designers who make imaginative use of silicones to increase the life and reliability of toasters, steam irons, and other appliances can often do so without adding a single penny to the cost of the finished product. A recent example is provided by Aluminum Goods Manufacturing Company, manufacturer of Mirro-Matic Percolators.

While Mirro-Matic's terminal pin insulators made of phenolic had proven satisfactory in normal use, the designers reasoned that abuse of the percolator could loosen electrical connectors and cause arcing. Phenolic is also prone to absorb moisture when splashed or dunked by careless users, raising a further possibility of insulator failure.

The risk of such breakdown, however, was entirely eliminated by the superior dielectric strength, heat and moisture resistance of silicone-glass laminates manufactured by Taylor Fiber Company. The moisture absorption of silicone laminate, for example, is only 0.02% compared with about 2% for phenolic.

And, because of the higher physical strength of silicone laminate, plain low cost stampings could be used instead of expensive molded parts. And they produced a further saving by reducing breakage during assembly.

The score: greater reliability for the Mirro-Matic Percolator without adding a cent to production costs! ***No. 330***

LOG STACKER *(Continued)*

in 5 minutes than three conventional yard lifts can handle in 30 minutes!

To provide maximum power and reliability every working motor — like all drive motors on all LeTourneau "electric wheel" equipment — is Class H insulated with Dow Corning Silicones. ***No. 331***

TRIPLE PUMP LIFE *(Continued)*

Dow Corning 3 Compound dissipates heat so effectively the pump remains cool even when pumping dry. No decrease in capacity or pressure has been noted after 3000 hours' operation at 1750 rpm. ***No. 332***

SILICONE DAMPING FLUID KEEPS ACCELEROMETER ON THE "ALERT"

Because Dow Corning Silicone fluids show little or no change in damping force over a wide temperature span, many engineers are utilizing them to produce performance features and economies not possible with organic damping oils. Here's how M. Ten Bosch, Inc., Pleasantville, N. Y. did it:

Capitalizing on the inherent physical and chemical stability of Dow Corning 200 Fluid, Ten Bosch has designed an accelerometer weighing a mere 2½ ounces that retains a sensitivity of plus or minus .006 G at up to 6 Gravities. The time constant of the unit is only .0002, yet it has absolutely no undamped natural frequency.

Dow Corning 200 Fluid was selected as the "integrating fluid" for this unit after tests on dozens of other materials including motor oil, kerosene, mineral oil, water and air failed to meet Ten Bosch's requirements. Non-corrosive, non-conducting and non-gumming, the 200 Fluid permits the accelerometer to retain all of its original alertness and sensitivity over a wide temperature span in aircraft, missiles, and gyroscope direction service. ***No. 333***

Dow Corning Corporation, Dept. 7012, Midland, Michigan

Please send me: 329 330 331 332 333
334 335 336 337 338 339

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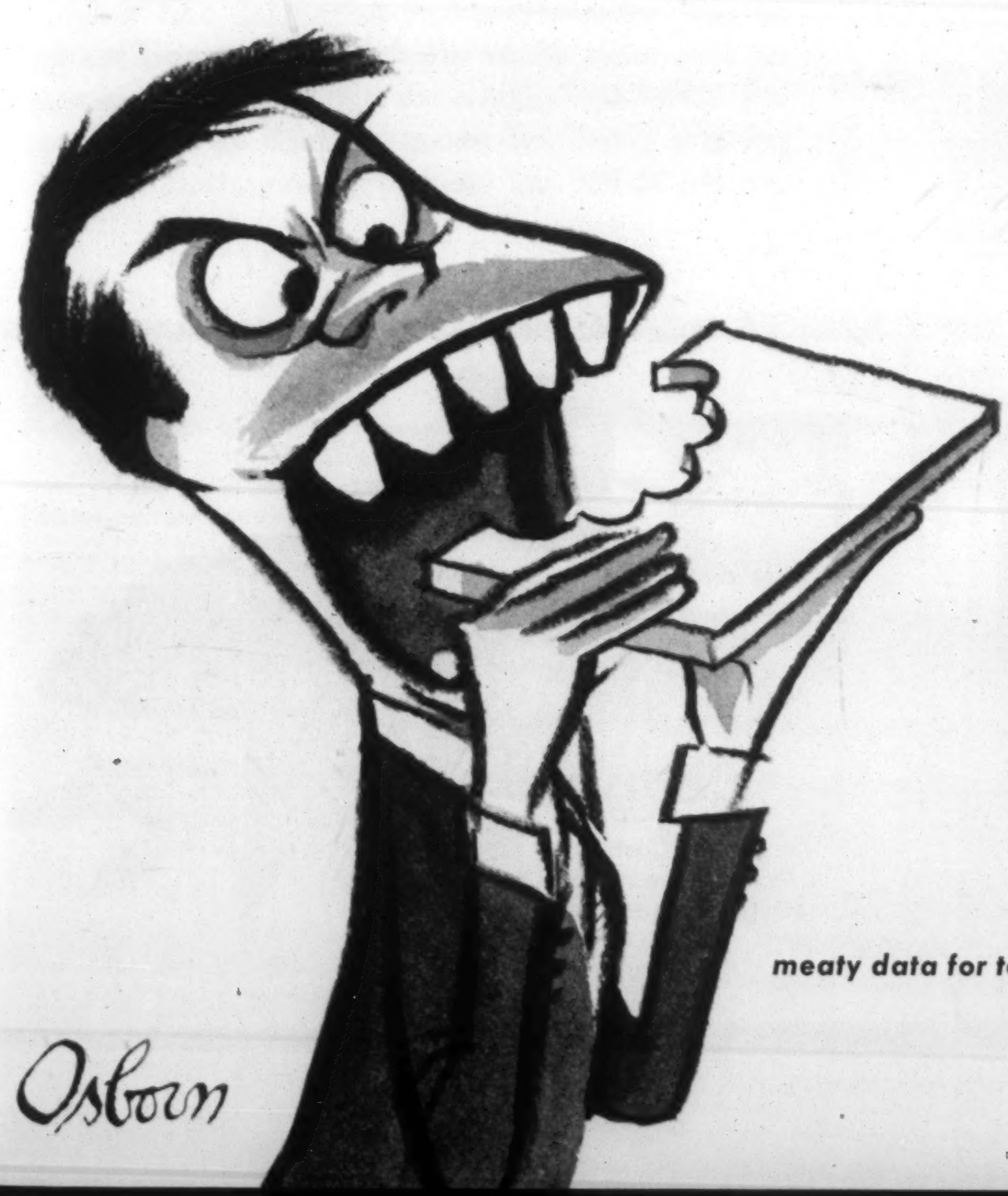
ALCOA'S UP-TO-DATER ON CASTINGS

Four new-development pages on super-strength impellers, uniform-wall castings, unusual permanent-mold castings, new high-strength alloys, and other meaty data for today's smart young men who will be supervisors tomorrow.



"Close Tolerances"—a Misnomer?

Precision, or close tolerance, casting saves a bundle on jobs that used to require much expensive machining. "Close tolerances" and "smooth finishes" are loosely used phrases. They mean anything tighter than the old sand foundry standard of ± 1/32″ and 500 micro-inches.

At Alcoa, by using plaster-mold processes, tolerances of 0.005″ are possible on certain jobs. Pattern smoothness and close tolerances are easily reproduced since the mold starts as a slurry of gypsum. And plaster molding is often combined with sand-and-iron molding to produce amazing castings.

Plaster molding, and its ability to be combined with other methods, add a new tool to the designer's toolbox. We'd like to explore the possibilities with you.

Sand casting, however, is still far from over the hill. It still is the cheapest method for a short run and certainly a widely used process at Alcoa. Occasionally, on certain small items we use match plate techniques and high-speed molding machines to knock them out faster and cheaper in sand than we can do in die castings or permanent-mold castings. Our sand castings run from a few ounces all the way up to a diesel engine cylinder block, 9′ x 6′ x 6′, weighing 7450 pounds.

Most Uniform Walls Ever Cast

Plaster castings with wall thicknesses down to .060″ are now being made at Alcoa. Tolerances are ± .005″ wall thickness. Right now, they're air scoops for the aircraft industry, made in both rounds and rectangles up to about 25″ long. Curved shapes present no problems. The process is more expensive but worth it because it cuts the weight of an air scoop in half. If your problem is thin, uniform walls, we'd like to explore the possibilities with you.

meaty data for today's smart young men

X364
C355
A 356

hopped on the new alloy band wagon to replace expensively machined and fabricated wrought parts

What Is a "Large Permanent-Mold Casting"?

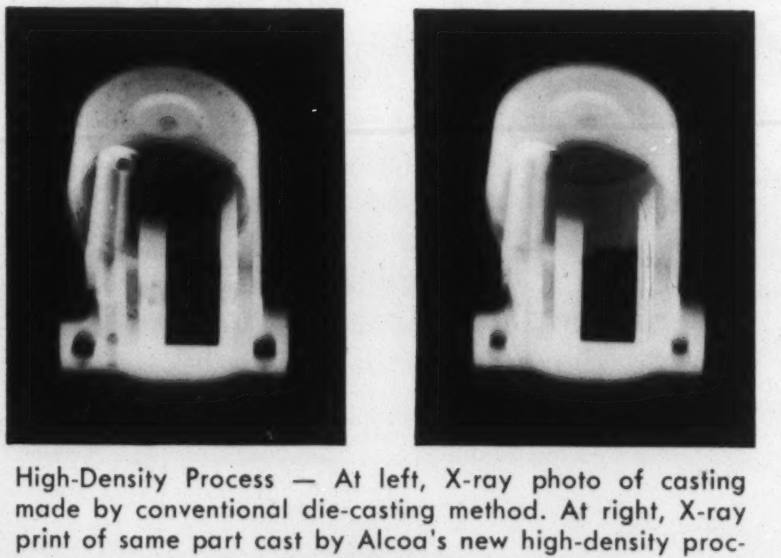
Not so long ago, permanent-mold castings larger than 12 inches and 2 or 3 pounds were rare as dodoes. Now we cast a cylinder of 800 pounds, 36 inches high, 30 inches diameter with 4-inch walls in permanent molds. The part is a rolling mill bearing. Others include engine pistons of 250 pounds, compressor cases for jets of 150 pounds.

We're now casting the entire bumper of a 1957 automobile . . . a routine permanent-mold job. These 28-pound castings are not only large but also are made in large quantities.

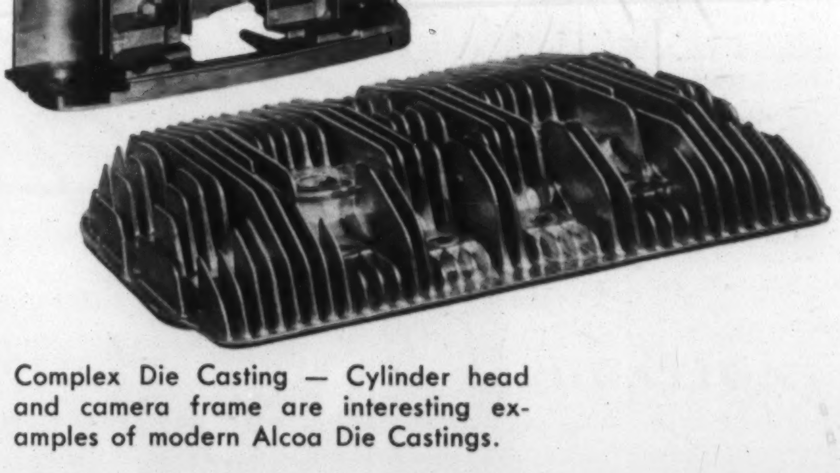
More than one designer has made himself a hero to his boss by looking into permanent-mold castings. Smooth and clean surfaces, medium-to-long production runs, tolerances of 1/64″ plus .002″ per inch (although 1/32″ in 5 feet has been made), good mechanical properties and modest complexity usually indicate permanent-mold castings.

Super-Strength and High-Speed Impellers

Imagine an impeller, 9½″ diameter, spinning at 60,000 rpm. Peripheral tip-speed tops 2500 ft. per second, 1800 mph. That's a casting recently turned out by a radical new manufacturing technique. Another impeller, to operate at 58,000 rpm, has delicate curved blades with the as-cast leading edges tapering to .020″. These two examples are used for turbo-charging and weigh 3 or 4 pounds. Other super-strength impellers for industrial refrigeration weigh 400 lbs. This new process gives properties as high as 50,000 psi tensile, 35,000 psi yield, 5% elongation.



High-Density Process — At left, X-ray photo of casting made by conventional die-casting method. At right, X-ray print of same part cast by Alcoa's new high-density process — porosity virtually eliminated.



Complex Die Casting — Cylinder head and camera frame are interesting examples of modern Alcoa Die Castings.

Cost-reduction note: The super-strength process can be combined with ordinary *cast* properties in the same part and at substantial savings.

Die Castings—Greater Use and Growing Size

Just a few years ago, aluminum die castings were used mostly as shrouds or covers. Now they're used for many structural parts. Reason: As labor rates have gone up, so has the use of die castings—to save assembly and machining costs. New alloys have given aluminum die castings greater strength and ductility: For air-conditioning compressor parts, automotive transmissions, vacuum cleaners, cylinder heads, etc. Alloys with high endurance limits are responsible for the increasing use of die castings in highly stressed reciprocating parts. As to size, office chair swivel bases and rotary lawn mower enclosures are now being die-cast at Alcoa.

high-density method for small, chunky parts

Alcoa has developed a high-density casting method for small chunky parts. Now soundness approximating wrought materials is possible as examination of the accompanying X-ray photos shows.

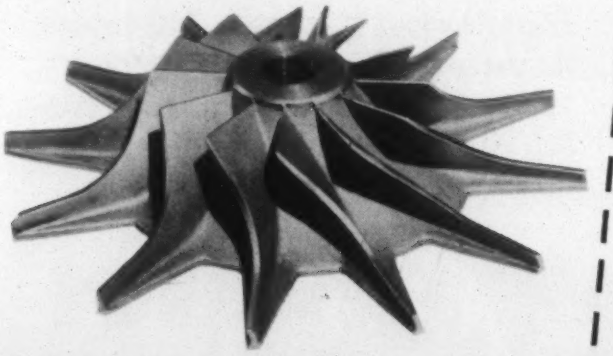
Need High-Strength Alloys? Here Are Three New Problem Solvers

Perhaps the toughest nut to crack in designing an aluminum casting is to pick the right alloy. That is, if you go it alone. Alcoa has over 40 standard casting alloys and each one is designed for a specific use. Your Alcoa representative is an authority on alloys. Use him.

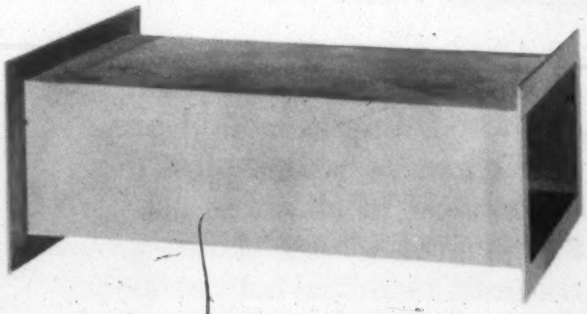
Several of the most recent alloys are worthy of special note: Two are alloys C355 and A356 *for permanent-mold work.* Being high-purity variations of the familiar 355 and 356, they require careful foundry handling but develop extremely high levels of strength and ductility. Shown, on the next page, are the properties for permanent-mold cast test bars for these new alloys in two tempers.

more than one designer has made himself a hero to his boss with permanent-mold castings

Super-Strength Impeller — Diesel engine turbocharger impeller spins at 58,000 rpm. Edges taper to air cleaving .020″. Plaster-casting process.



Large Permanent-Mold Casting — Rolling mill bearing goes 800 lbs., 3 ft. high, 2½ ft. diameter, 4 in. walls.



Uniform Walls — Plaster-cast air scoop includes walls with thicknesses of .060″, with wall tolerances of .005″.

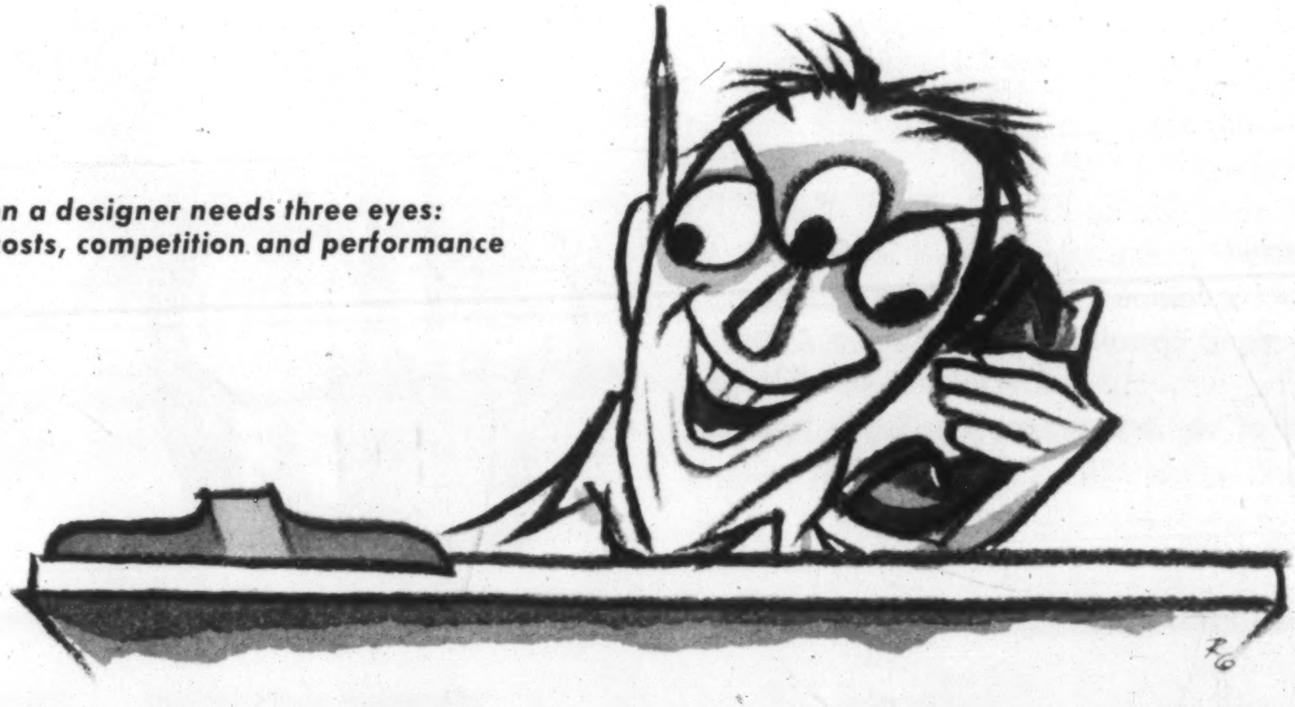
Mechanical Properties

In the die-casting field, alloy X364 is going to increase applications where strength in highly stressed parts is important. Its properties are roughly equal to those of alloy 218, but it's easier to cast and therefore cheaper. Its price will be slightly higher than 380 and 360 alloys so it shouldn't be specified as a replacement for those alloys unless higher strength, better elongation and impact resistance are needed. Shown is a chart giving typical properties (obtained with die-cast ¼" test bars) of this experimental alloy X364, as compared with 218, 360 and 380 alloys.

	Guaranteed Minimum			Typical		
Alloy & Temper	Tensile psi	Yield psi	Elong. %	Tensile psi	Yield psi	Elong. psi
C355-T61	40,000	30,000	3.0	46,000	34,000	6.0
C355-T62	47,000	40,000	1.5	52,000	44,000	4.0
A356-T6	32,000	18,000	10.5	37,000	22,000	15.0
A356-T61	37,000	26,000	5.0	41,000	30,000	10.0

Alloy	Temper	Tensile Strength-psi	Yield Strength-psi	Elongation %
X364	—F	41,000	22,000	7.5
X364	—T5	46,000	33,000	4.0
218	—F	45,000	27,000	8.0
360	—F	44,000	27,000	3.0
380	—F	43,000	26,000	2.0

Right now the ones who have hopped on the C355, X364 and A356 alloy band wagon are designers who are using these alloys to replace wrought structures which involved expensive machining and fabrication. But we expect real interest from designers faced with any part subject to impact. Stir up any ideas?



when a designer needs three eyes: for costs, competition and performance

Straight Talk

In these days, when a designer needs three eyes, one for costs, one for competition and one for performance, he has often found the answer to all three problems in Alcoa® Castings. Many times, the solid technical help contributed by the Alcoa sales engineers and casting specialists has either cut costs or improved performance. And, *because Alcoa offers all casting processes their recommendations are completely unbiased.*

The nicest thing about this help is that it's free and waiting at your local Alcoa office, listed under "Aluminum" in your classified phone book. Better yet, write for your copy of Alcoa's new technical book, *Alcoa Aluminum Handbook*, 176 pages, 140 tables. ALUMINUM COMPANY OF AMERICA, 1994-M Alcoa Building, Pittsburgh 19, Pennsylvania.

Your Guide to the Best in Aluminum Value

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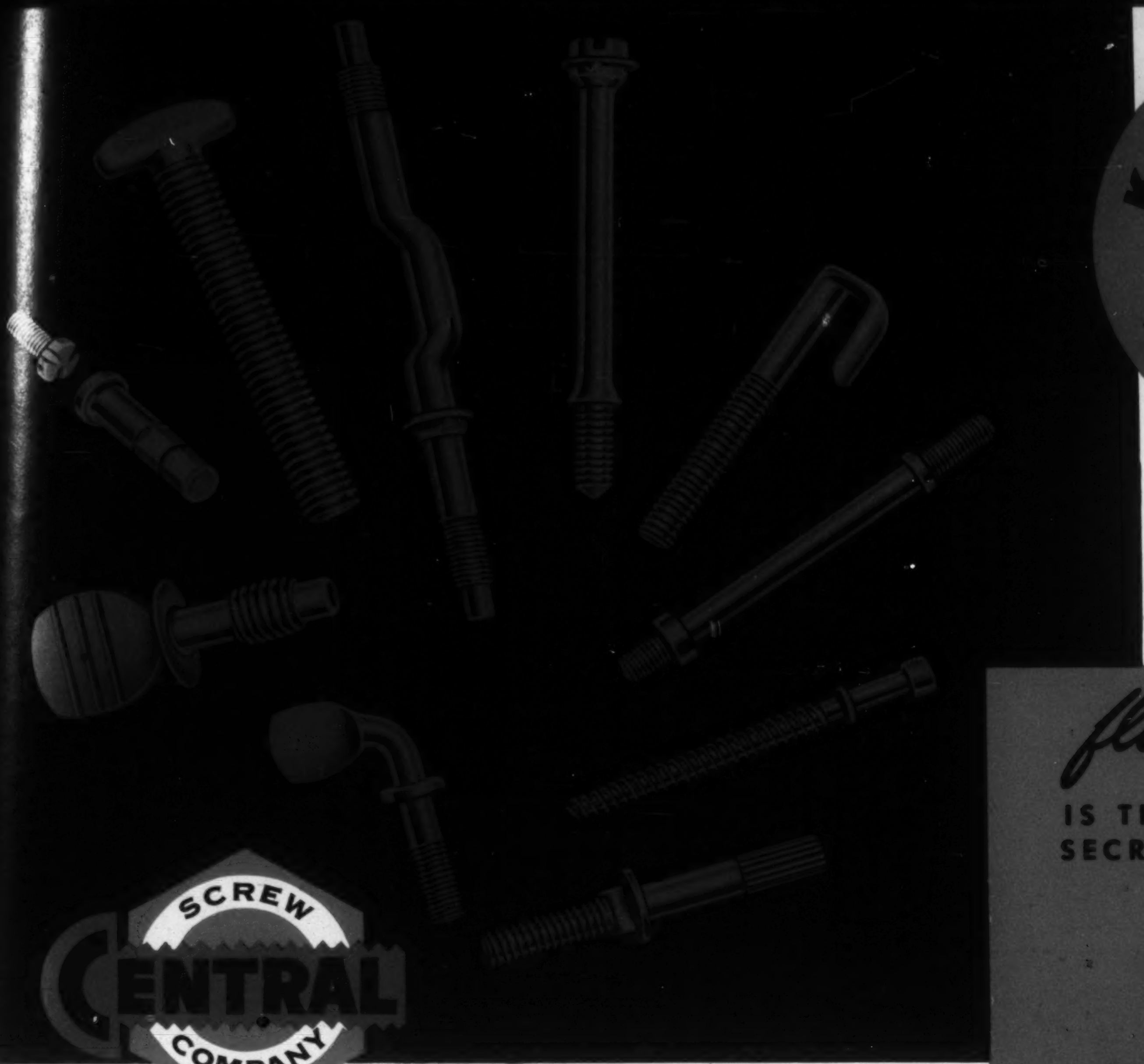
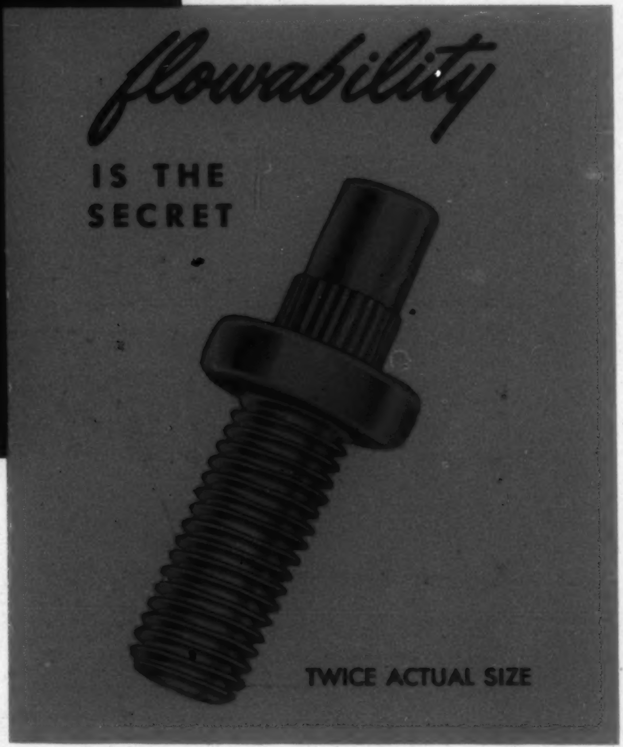


SCREW CENTRAL COMPANY

KEYSTONE XL WIRE STUDY



Tough cold heading jobs...

longer runs . . . lower costs

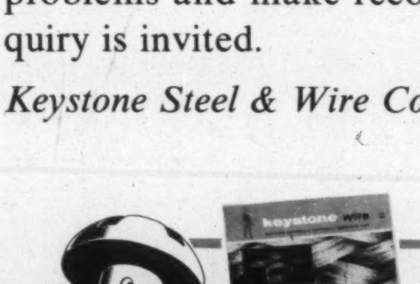
CENTRAL SCREW CO. of Chicago, Illinois, tackles many intricate cold heading jobs. A few are illustrated. All are processed from Keystone "XL" Wire. The auto horn mounting stud, shown in the color panel, was a tough forming job, upset in two blows. After trying other wires, Central Screw Co. changed to Keystone "XL" Wire and successfully produced this part with much longer runs due to increased die life. Rejections were cut to a minimum. The result—a quality finished product at a lower cost.

Time and again, quality Keystone "XL" Cold Heading Wire has made it possible to perfectly form the most intricate fasteners or parts. A Keystone Wire Specialist will gladly discuss your problems and make recommendations. Your inquiry is invited.

Keystone Steel & Wire Company, Peoria 7, Illinois

KEYSTONE

WIRE FOR INDUSTRY



KEYSTONE STEEL & WIRE COMPANY
Peoria 7, Illinois

Mail coupon for free booklet—*COLD HEADING FACTS!* Discusses methods, technical facts, wire requirements and other data.

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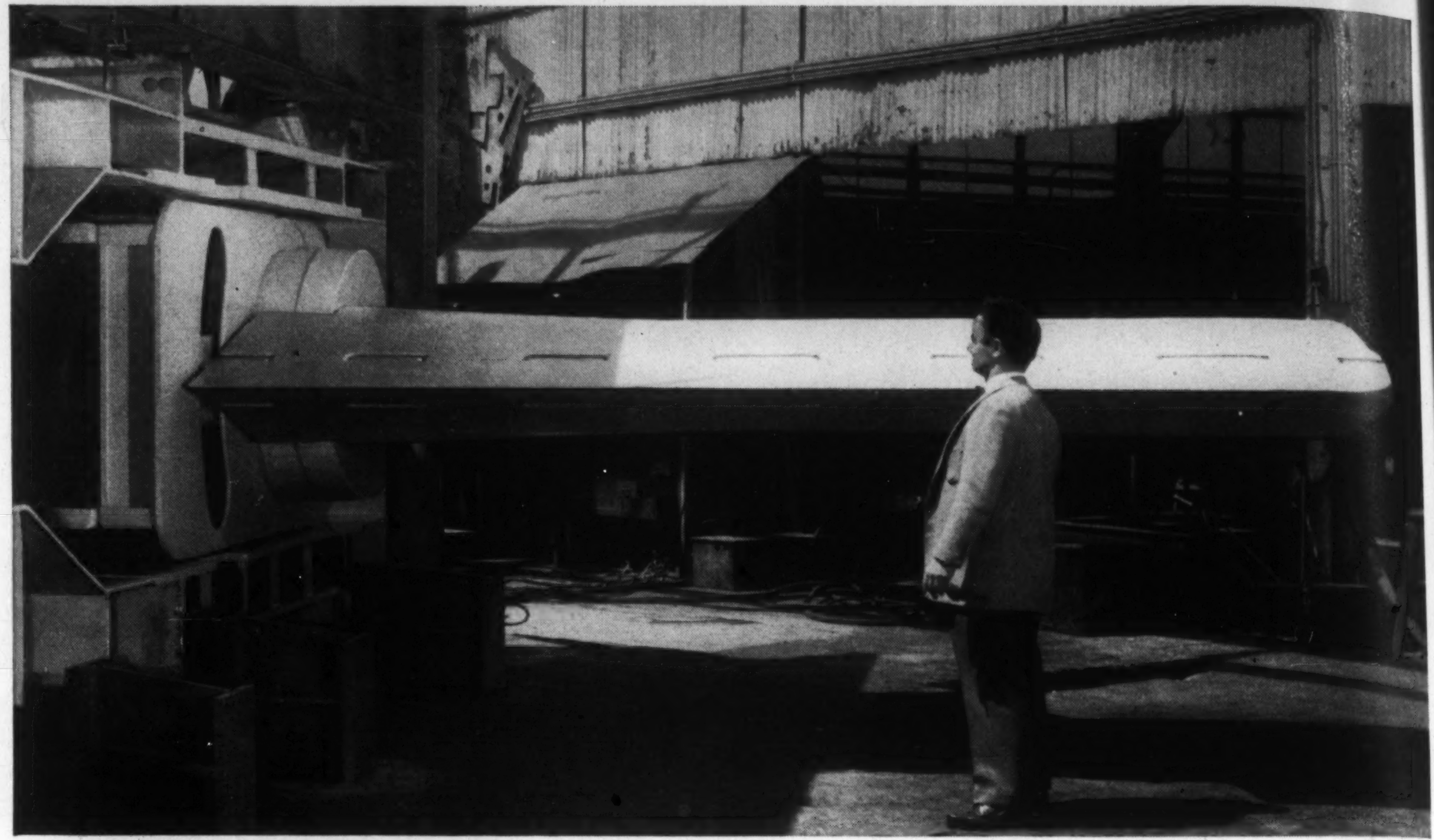

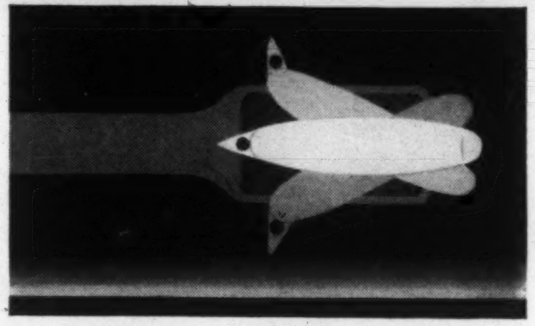

Reduces ship roll up to 90% – First commercial installations of the Sperry Gyrofin are on the Matson liners, *Mariposa* and *Monterey*. The design calls for strong, corrosion-resisting Inco Nickel Alloys at key locations: "K" Monel hinge pin . . . Monel nickel-copper alloy spacer rings . . . Monel overlay (welded with "140"* Monel Electrode) on flap control surfaces.

Sketch at left shows the tilting range of the underwater fins that keep a ship steady. One fin extends from each side of the hull amidships.

"K" Monel allows sea water lubrication in new Sperry-designed Gyrofin

See the flap on the fin above?

It's a key part of the Sperry Gyrofin® Ship Stabilizer, a new invention to keep ships steady in heavy seas.

Designing the flap hinge posed two problems for Sperry engineers.

First . . . high strength. A hinge pin was needed that could take its full share of *3,000 foot-tons* of anti-rolling moment.

Second . . . positive lubrication. Almost instantaneous response to computer instructions is required . . . fin (and flap) sometimes change direction *every two seconds*. But how could the hinge area be sealed off and lubricant supplied?

A "K" Monel age-hardenable nickel-copper alloy hinge pin *solved* Sperry's first problem . . . *by-passed* the second.

This rod, 4½-in. dia. by 15 ft. long is strong enough to hold the flap firmly in position as it withstands the battering force of ship and sea. And the exceptional corrosion resistance of "K" Monel permits use of *sea water* as a lubricant...eliminates the need for a sealed hinge!

Designing parts for operation in corrosive media?

Or for other destructive service conditions? Investigate the Inco Nickel Alloys. Their properties and applications are described for designers in a helpful booklet . . . "Standard Alloys for Special Problems." A postcard brings your copy.

The International Nickel Company, Inc.
67 Wall Street New York 5, N. Y.

INCO NICKEL ALLOYS

Monel* • "R"* Monel • "K"* Monel • "KR"* Monel • "S"* Monel
Inconel* • Inconel "X"* • Inconel "W"* • Incoloy* • Incoloy "T"*
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TORRINGTON ROTARY SWAGING MACHINES...

featuring

- ★ maximum capacity for size and power
- ★ convenient location of controls
- ★ easy access for maintenance
- ★ integral storage space
- ★ modern styling and color

How the new *streamlined* Torrington Rotary Swaging Machines save material, labor and time

These modern swaging machines are versatile, efficient tools that shape metal by thousands of hammer blows each minute.

Many tapering, pointing, reducing and shaping operations can be done by swaging with these big advantages:

Swaging saves material that would otherwise be turned away as scrap.

It saves labor, performing many operations in a fraction of the time required by other methods.

It imparts greater strength, improved grain structure and a surface hardness that *only* hammering can produce.

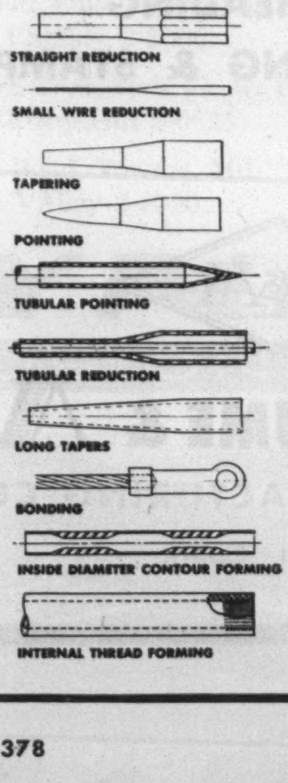
It produces a fine burnished finish, usually to a closer tolerance than machining.

Torrington also supplies "Job-Tested" Swaging Dies, designed to your prints or to the part you wish to produce. Send us prints or a sample of your part, and we will advise you on selection of the proper machine for the work and supply the proper dies.

THE TORRINGTON COMPANY
Swaging Machine Division
660 North Street, Torrington, Conn.

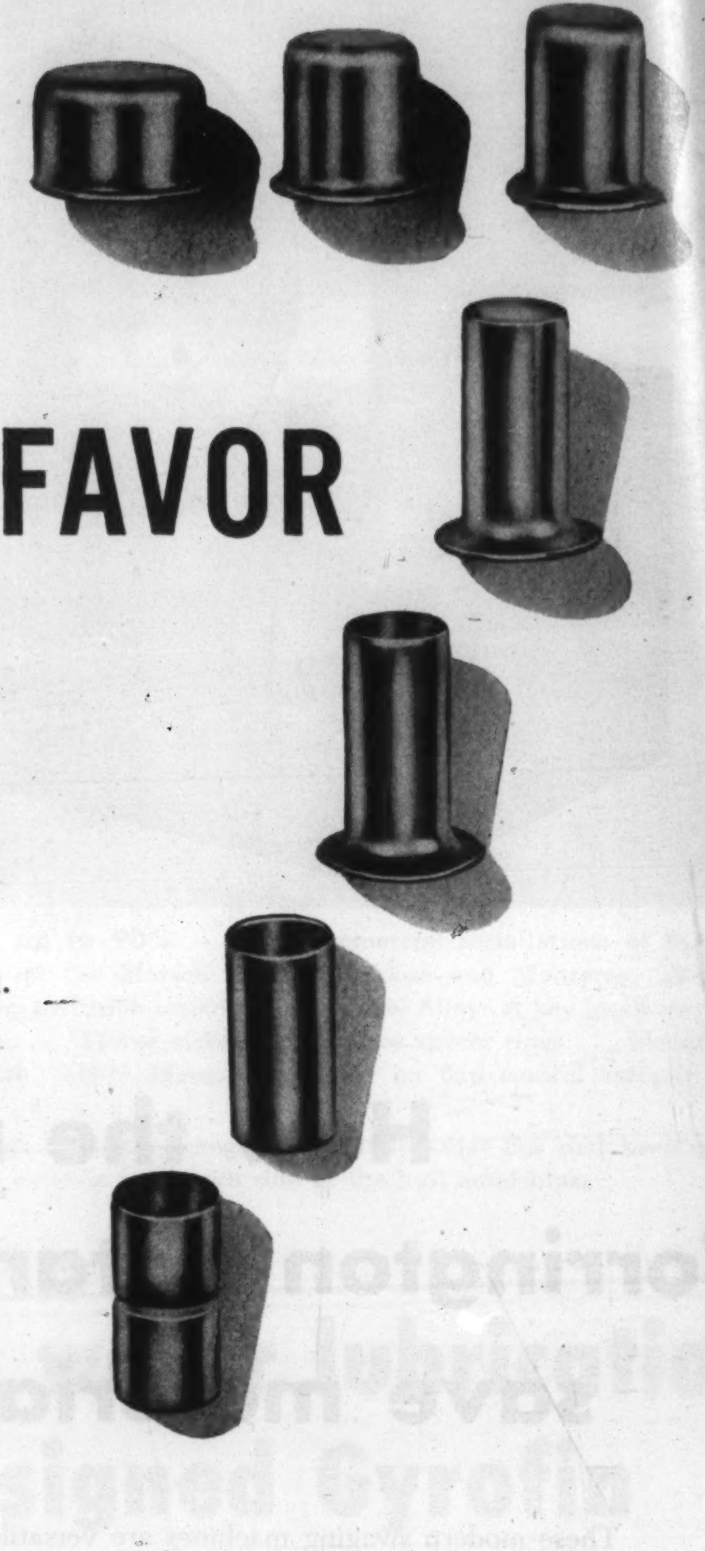
TORRINGTON ROTARY SWAGING MACHINES
Makers of Torrington Needle Bearings

YOU CAN SWAGE THESE SHAPES AND SAVE


STRAIGHT REDUCTION
SMALL WIRE REDUCTION
TAPERING
POINTING
TUBULAR POINTING
TUBULAR REDUCTION
LONG TAPERS
BONDING
INSIDE DIAMETER CONTOUR FORMING
INTERNAL THREAD FORMING

For more information, turn to Reader Service Card, Circle No. 378

THE ODDS ARE
7 to 1 *or better* IN YOUR FAVOR



For each *additional* operation that can be scheduled on P&A multiple station machines, chances are your costs will decrease in proportion. Whether you need component metal parts of brass, copper, steel, aluminum, Monel, Stainless or zinc, P&A has the fabricating facilities to do the job.

Call on us for

PROGRESSIVE DIE WORK
BLANKING & COINING
COLD HEADING
DRAWING & STAMPING

P&A
ESTABLISHED 1869

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PLUME & ATWOOD
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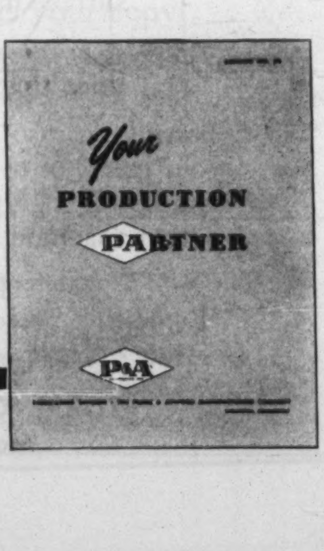
This *NEW* brochure is yours for the asking. Find out how P&A can save you production headaches.



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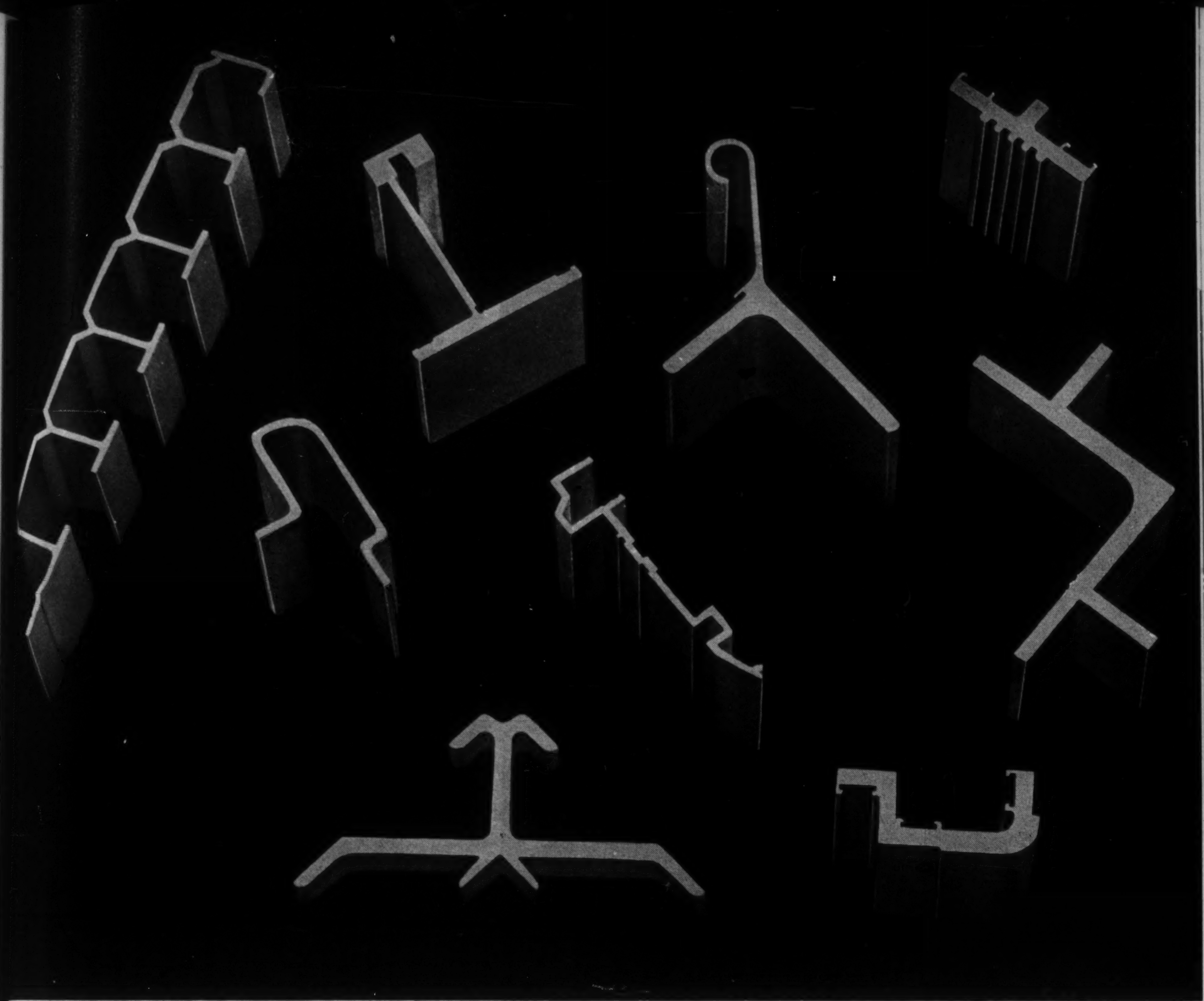

"Plain and Fancy"

A simple "U" channel, or the most complicated profile, receive the same expert attention when they're extruded in aluminum by Flynn. Qualified metallurgists make certain that the proper alloys for the extrusions are used. Competent designers check profiles to assure maximum strength with minimum material. Whether your aluminum extrusion is custom designed, or taken from Flynn's tremendous stock of dies, you can count on quality, a fair price, and fast service. Ask Flynn first — estimates given promptly.

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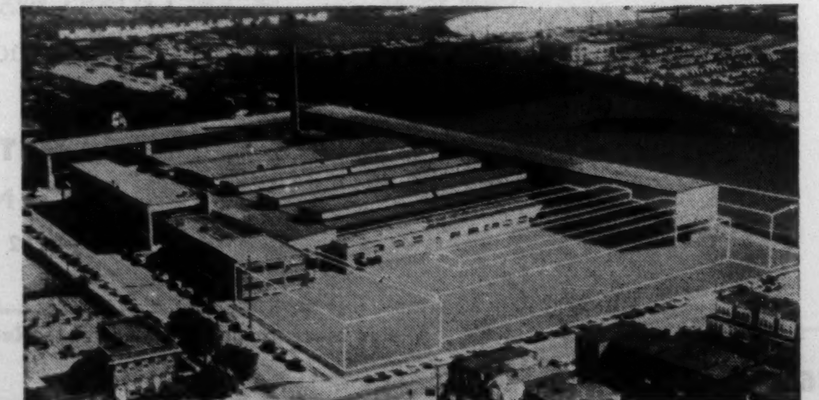
Extrusion Division
700 East Godfrey Avenue, Philadelphia 24, Penna.
Telephone: FIdelity 2-5500

51 East 42nd Street, New York 17, N. Y.
Telephone: MUrray Hill 2-0625

937 Radcliffe Road, Towson, Md.
Telephone: VAlley 3-2090

FLYNN
EXTRUSIONS

Free Pocket Guide, "Standard Tolerances: Aluminum Extruded Shapes." Gives standard tolerances for rods and bars, mechanical properties for four aluminum alloys in various tempers. Permanently protected in laminated plastic. Fits shirt pocket. Please send all requests on company letterhead.



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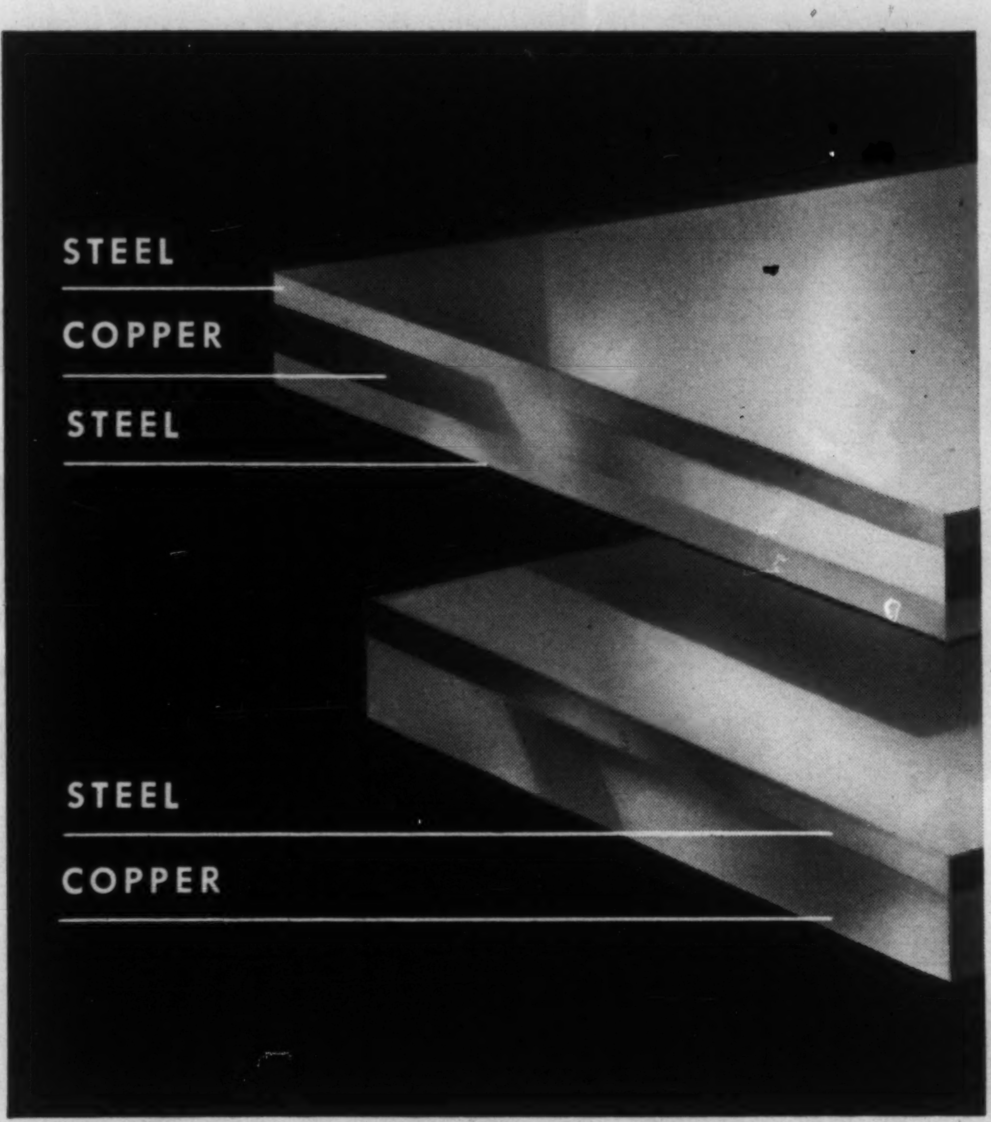
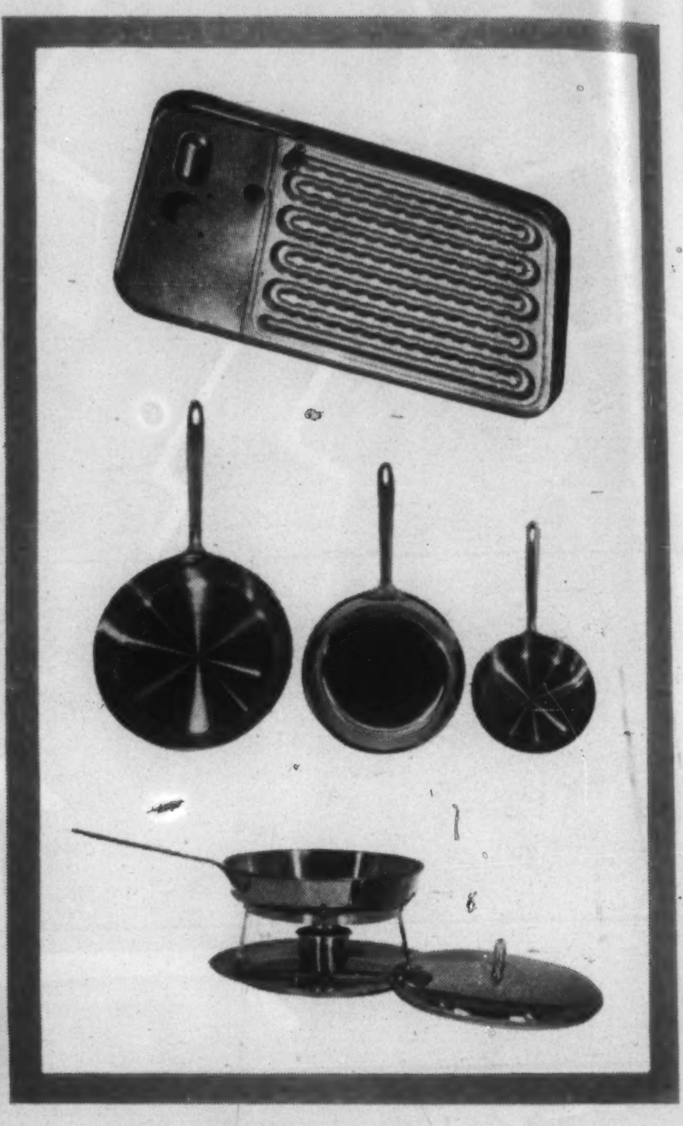
Two Metals

are often **Better** than one!





...and GENERAL PLATE Stainless Clad Copper is a case in point

Here's what General Plate Stainless Clad Copper offers:

- **High thermal and electrical conductivity for excellent heat transfer**
- **Corrosion resistance equal to stainless steel**
- **Superior performance at elevated temperatures**

You can profit by using General Plate Clad Metals

General Plate's Stainless Clad Copper strip adds the superior thermal conductivity of copper to the high temperature corrosion resistance of stainless steel. Molecularly bonded without brazing alloys or other intermediate agents, these two metals combine in clad form to offer improved characteristics for a wide range of applications involving electrical conductivity or heat exchange.

If you are interested in metals with new and better characteristics — look to General Plate Clad Metals. Write today without obligation for new catalog, PR-700A, describing many clad metal combinations — both precious and base metal; TRUFLEX® Thermostat Metals; composite electrical contact buttons and rivets.

METALS & CONTROLS CORPORATION
GENERAL PLATE DIVISION
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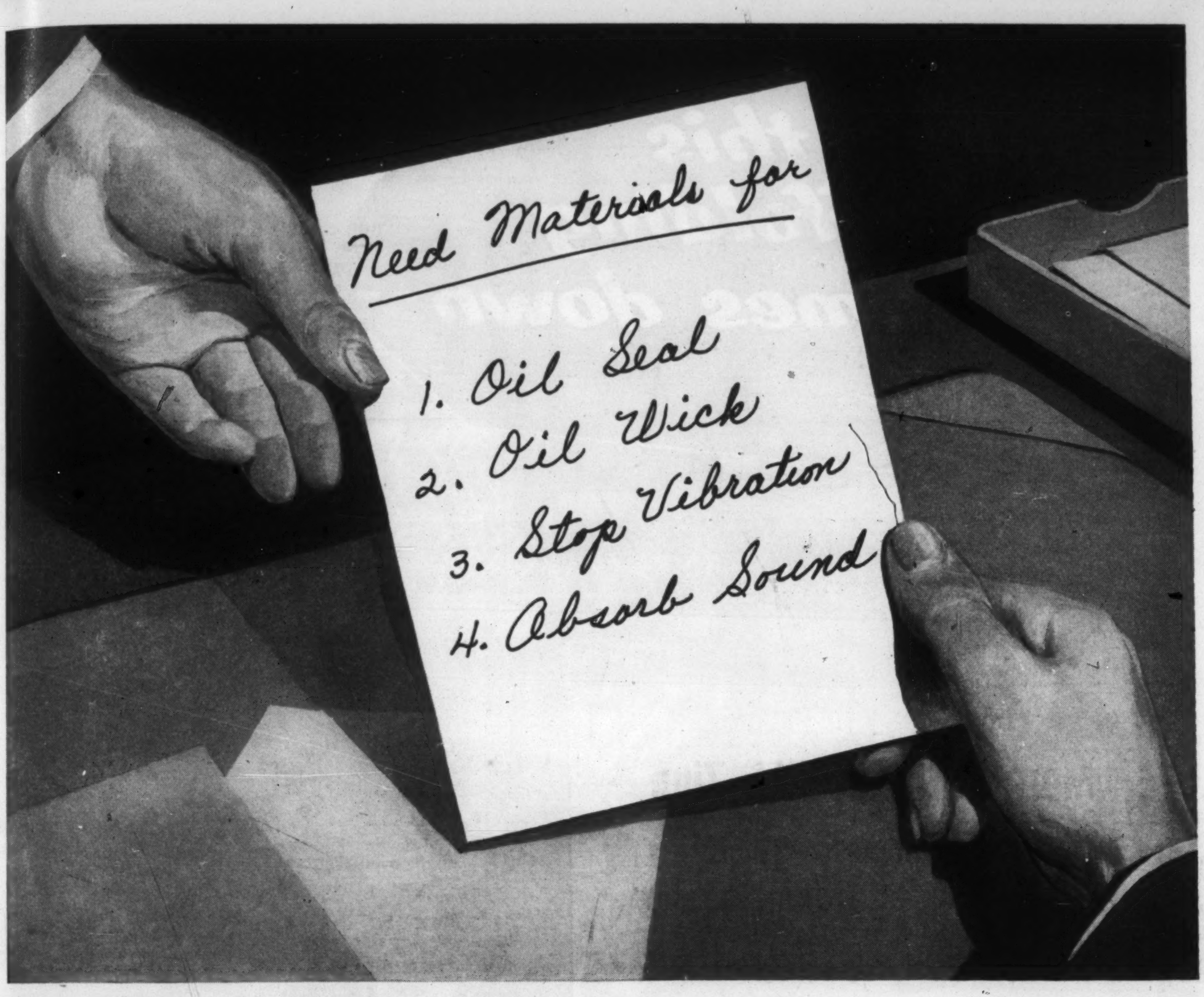

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Western Felts can be made as soft as virgin wool or as hard as bone—or any desired specifications in between. But always, their live fibers hold their shape. They never ravel or fray . . . resist wear, age, and weather.

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TRADE MARK

MANUFACTURERS AND CUTTERS OF WOOL FELT

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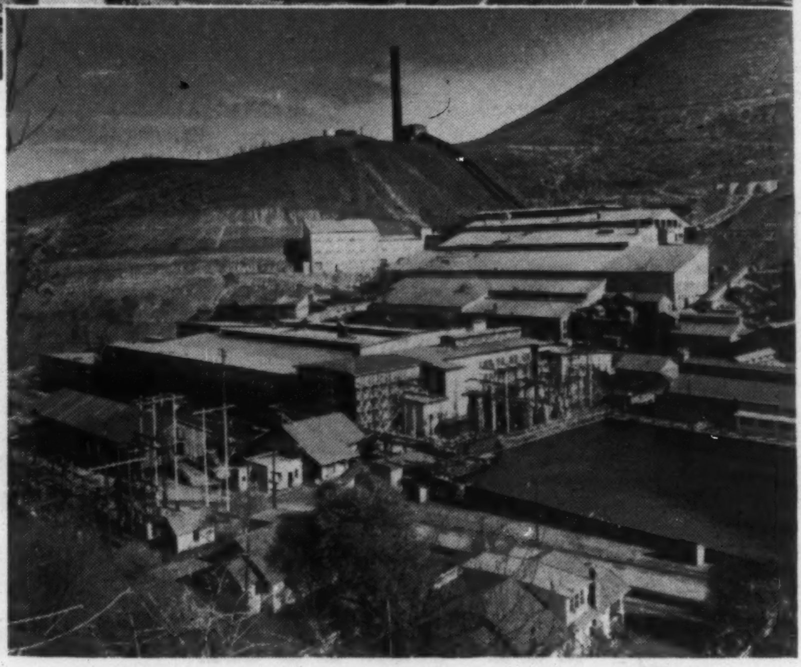
When this scaffolding comes down--



More BUNKER HILL Zinc

—first and foremost 4-9 metal— available for a fast growing industry

DIE CASTING

U. S. Department of Commerce figures indicate that in the last decade the die casting industry has increased its use of non-ferrous metals 150%—two-thirds of which is zinc. The Bunker Hill Company, to meet this demand, is expanding its capacity 25% early in 1957 at an expenditure of seven million dollars to be followed by an additional expansion in 1958, to bring the output of Bunker Hill Zinc up to 7,200 tons a month. By contrast the first Bunker Hill plant had a capacity of 1,500 tons per month. It was built in 1928 and the introduction of this first 99.99+% zinc revolutionized the die casting industry.

Thus, Bunker Hill not only has kept pace with the rising demand for this excellent metal but is anticipating future needs of the expanding die casting industry.

Die Casting the process, Zinc the metal,
Bunker Hill the preferred zinc.

BUNKER HILL 99.99+% ZINC

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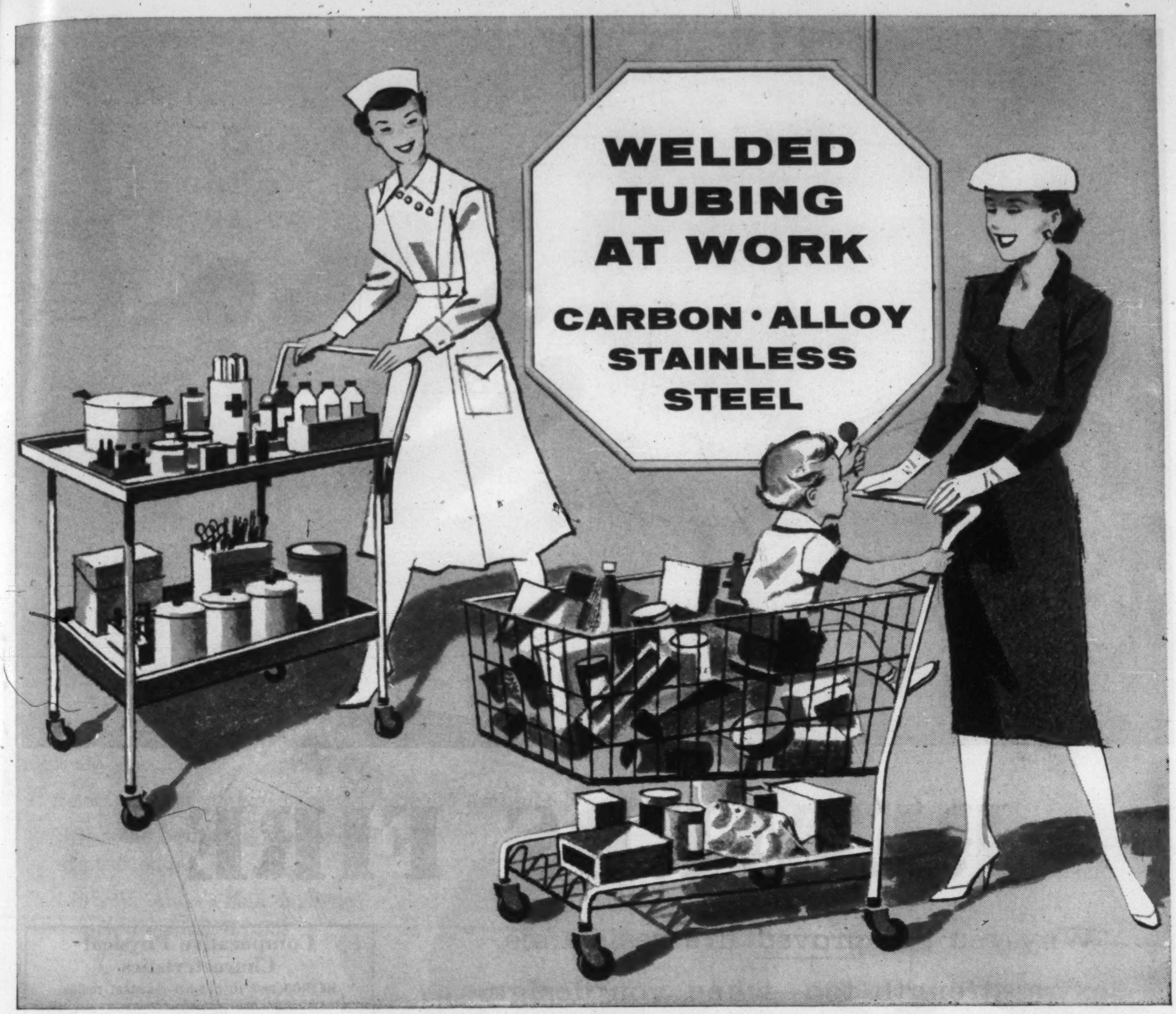
SALES OFFICE FOR PACIFIC COAST **THE BUNKER HILL COMPANY** 660 MARKET STREET, SAN FRANCISCO 4, CALIF.



Tubing Does More Jobs Better

Structurally, mechanically, as a conveyor of liquids or gases, in demanding high temperature service, or corrosive conditions—there is a grade of Welded Tubing which can do your job economically.

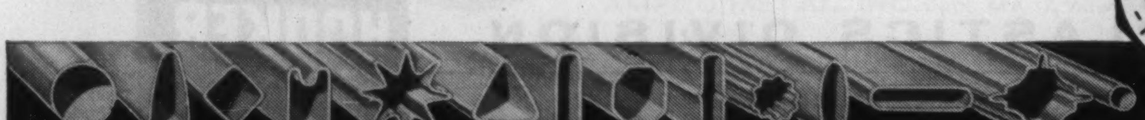
Physically, the tube is your most versatile and efficient structural form and with *Welded* Tubing you get the added benefits of uniformity of wall thickness, concentricity, close tolerances, uniform physical properties and surface finish.

Bend it . . . you have no sharp corners. Form it any way you like. Fasten it by any commercial method. Finish it by a score of methods. If a special cross section is desired, remember, the chances are your Welded Tube supplier can furnish it. Draw upon the specialized benefits of a complete range of carbon, alloy and stainless steel grades. From capillary sizes up to 6″, quality-made *Welded* Tubing in all grades is your most effective material.

WRITE—This 268-page "Handbook of Welded Steel Tubing" can be obtained from your FSTI tubing supplier or at nominal cost from Formed Steel Tube Institute, 850 Hanna Building, Cleveland 15, Ohio.

THE RECOGNIZED PRODUCERS OF QUALITY WELDED CARBON, ALLOY AND STAINLESS STEEL TUBING

FORMED STEEL TUBE INSTITUTE
FSTI



For more information, turn to Reader Service Card, Circle No. 541

RETARDS FIRE

Why you get proved fire resistance, extra strength too—when you design or build with HETRON® polyester

You can buy HETRON polyester sheet right now that carries one or both of these labels.

The Underwriters' label tells you the flame-spread rating of the sheet (as measured by ASTM E84-50T). Now you can classify plastic panels in relation to conventional building materials.

The F-M label tells you that Factory Mutual Laboratories rate this sheet "fire-retardant"—after putting the torch to 2,000 square feet of it on the roof of a building.

The fire-retardant sheet opens up a whole new concept of daylighting for large buildings.

This is only *one* example of what you can do with HETRON polyester sheet or large molded parts.

Some others are: 40-foot boat hulls; 60-foot radomes; aircraft parts; truck fenders; electric insulating board; fire-resistant sandwich panels.

You get HETRON's locked-in flame resistance *without any sacrifice of physicals.* Some designers specify HETRON for its outstanding physicals and molding qualities alone. They get fire resistance as an added bonus.

For aircraft, you can get HETRON resins manufactured to meet MIL-R-7575A, Types I, II, and III.

If you'd like more facts on HETRON, consult Sweet's File (Product Design) or Modern Plastics Encyclopedia. For specific test results and names of fabricators who can supply you with HETRON sheet or molded parts, write us today.

Comparative Physical Characteristics

HETRON and 10 non-fire-resistant resins

Physical Property		Rigid Resins		Semi-rigid Resins
		HETRON 92	Avg. 10 Others	HETRON 32 A
Flexural Strength. PSIx10^3	Room Temp.	**38.6**	36.4	**41.8**
	180°F.	**25.0**	18.6	**23.5**
Flexural Modulus, PSIx10^6	Room Temp.	**1.88**	1.61	**1.82**
	180°F.	**0.90**	0.79	**0.85**
Tensile Strength, PSIx10^3		**21.7**	22.0	**21.0**
Water Absorption, Pct. by Wt.		**0.13**	0.29	**0.13**

SUPERIOR PHYSICALS of HETRON show up in independent tests on panels 0.1" thick containing 35-40% glass mat, 17-20% filler, and the balance resin.

DUREZ® DUREZ PLASTICS DIVISION

HOOKER CHEMICALS PLASTICS

663W14

HOOKER ELECTROCHEMICAL COMPANY
3412 Walck Road, North Tonawanda, N. Y.

For more information, turn to Reader Service Card, Circle No. 528

AMPCO — ONE-SOURCE SERVICE FROM RAW MATERIAL TO FINISHED PRODUCT

Your Ampco field engineer has *no axe to grind* — when it comes to copper-base alloys

Ampco supplies them all — and in any form of production

What does an alloy have to do for you? Resist wear, corrosion, impact, fatigue? Provide excellent bearing qualities? Retain physical characteristics at temperatures from 600°F down to -400°F?

Should it be sand-cast, centrifugally-cast, shell-molded, precision-cast, forged, fabricated, or extruded? Sheet or plate?

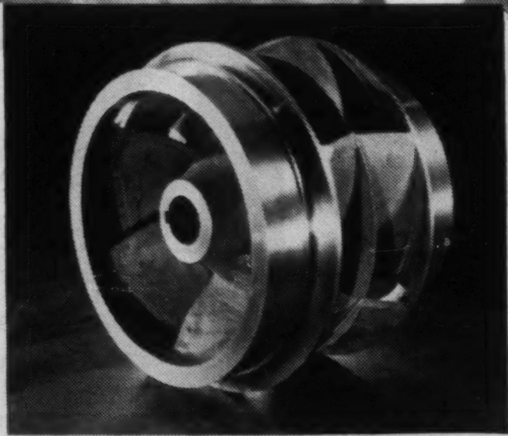
Whatever your design requires, your Ampco field engineer can help you . . .

1. Select the best alloy, from more than 100 Ampco copper-base alloys.
2. Select the best, most economical form of production.

Call in your Ampco field engineer.
And write for Bulletin 33.

Metal for 4,000-pound casting being poured into vertical-spindle centrifugal-casting machine. Ampco makes centrifugal castings in sizes up to five tons.

Ampco's one-source service includes production-run machining of Ampco copper-base alloys to the quality standards of the aircraft industry.

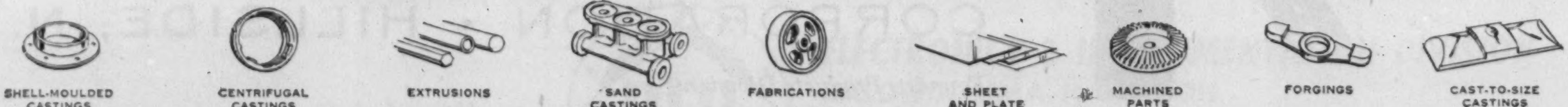


Difficult coring problems are solved every day in Ampco's modern sand foundry. Ampco produces sand castings in any size up to 14,000 pounds.

AMPCO®

THE METAL WITHOUT AN EQUAL

AMPCO METAL, INC. Dept. MA-12, Milwaukee 46, Wisconsin • West Coast Plant: Burbank, California



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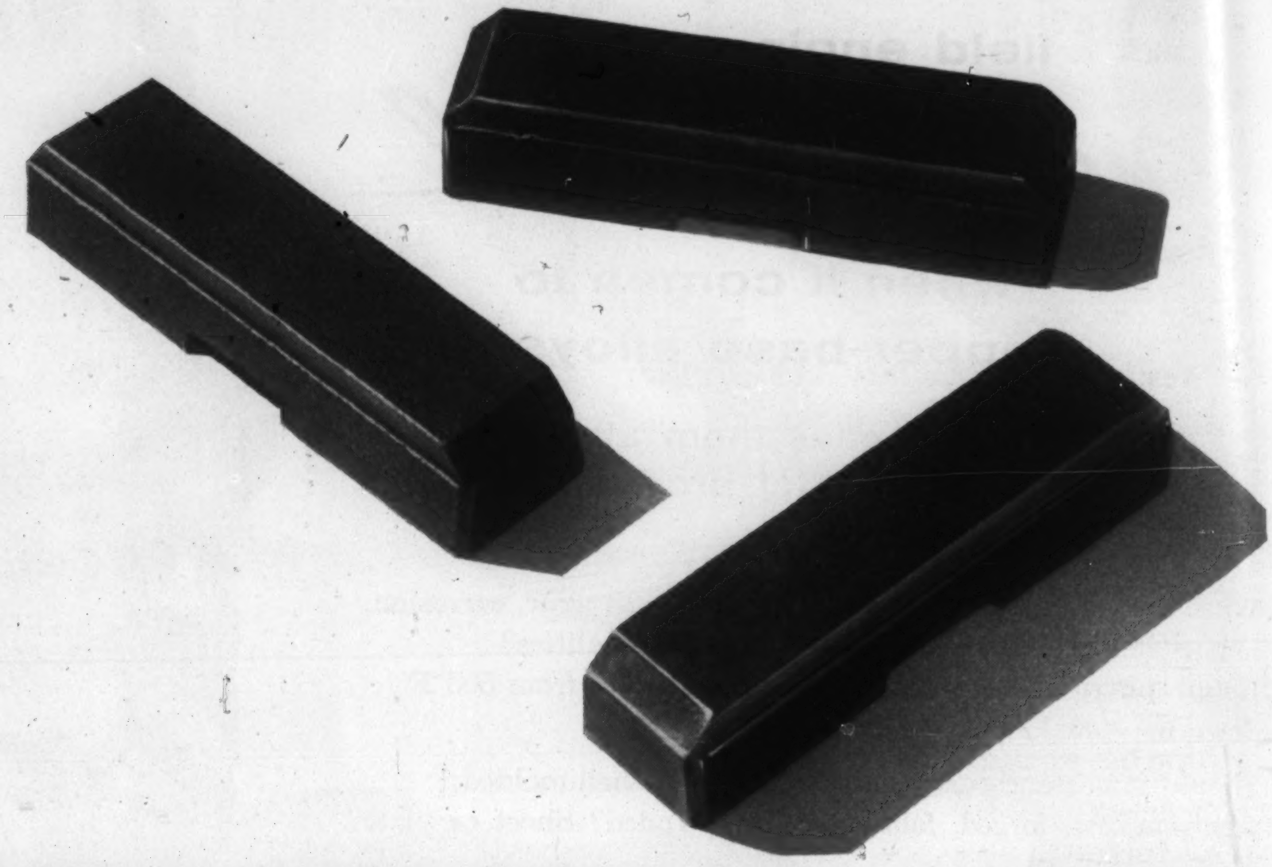
Costs cut 50% on these stainless steel castings



COOPER ALLOY SHELLCAST® PROCEDURES AND ADVANCED KNOW-HOW MAKE A TOUGH JOB EASY

These stainless steel defibering blades are used by E. D. Jones & Sons, Pittsfield, Mass. on the Hi-speed rotor of their unique Hi-Lo Pulper, a new advance in better and faster pulp and paper defibering.

To achieve highest efficiency, E. D. Jones required these blades to have dimensional accuracy (± .005 in.), a fine smooth surface free from defects, clean sharp edges and impact resistance to metallic impurities at velocities of 7,000 fpm.

The production method previously used was to machine them entirely from bar stock. Through use of the Cooper Alloy Shellcast® method and shell coring procedures to obtain high quality and accuracy, these blades were cast by Cooper Alloy at a savings of 50%.

As a result of Cooper Alloy Advanced Know-How, another difficult stainless steel casting has become a standard production job.

For further information, write for Bulletin AKH#5.

COOPER ALLOY
CORPORATION • HILLSIDE, N. J.
Foundry Products Division

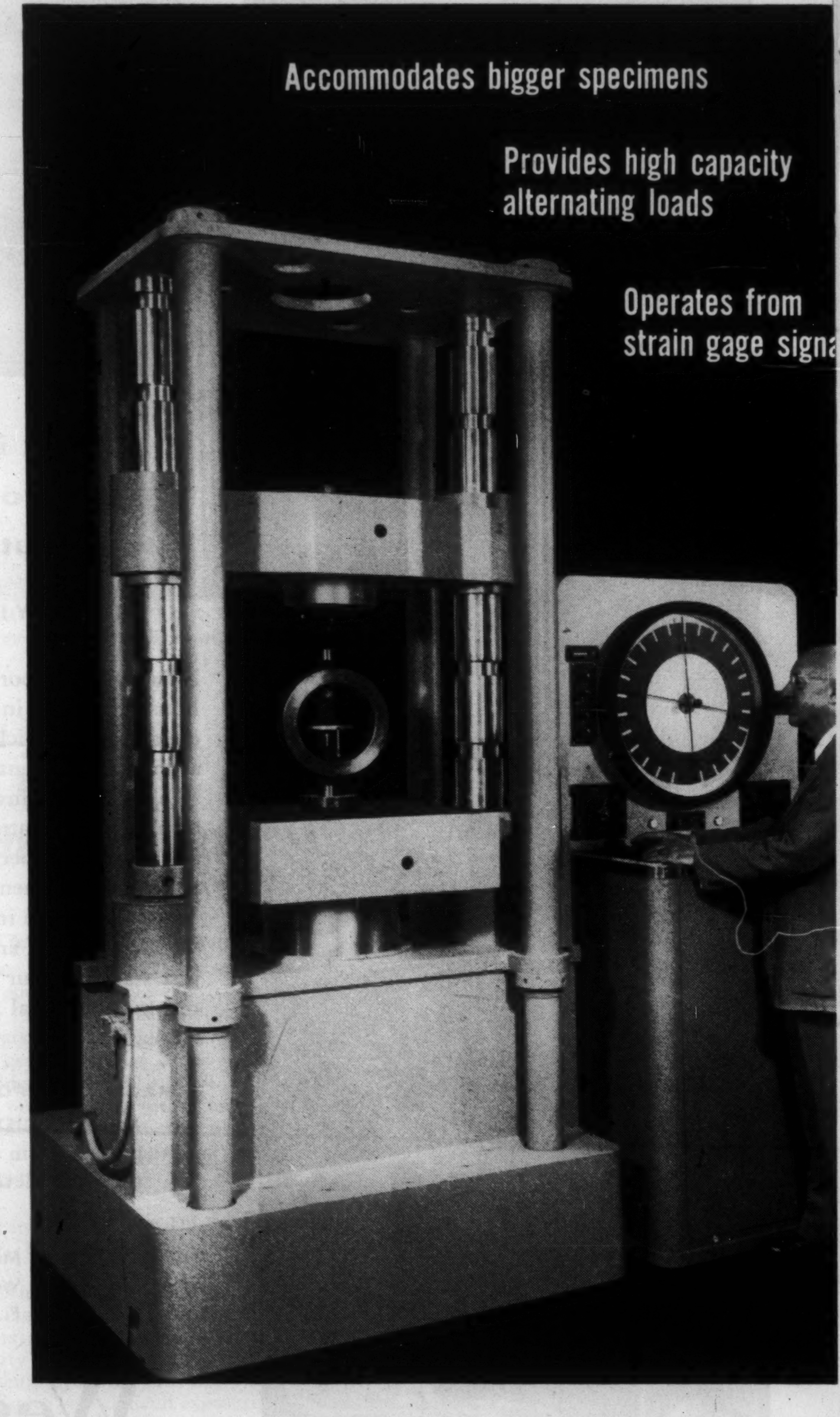
For more information, turn to Reader Service Card, Circle No. 568

new 150,000 lb. capacity Baldwin SR-4® universal

From "Testing Headquarters" comes this new Model FGT 150,000 lb. universal testing machine with all these advantages for *you:*

- Full 30″ clearance between columns, plus greater height to accommodate bigger specimens.
- Machine has greater rigidity (due to stay plates at top) and is more resistant to lateral forces (it's a screw within a piston running in a cylinder which supports it in every direction).
- Equipped with ball bearing screw.
- Provides load cycling without changing position of specimen.
- SR-4 indicating unit has practically instantaneous response.
- Can be operated from strain gage signals to reproduce service conditions in the laboratory. Signals from actual field tests are stored on magnetic tape to control this testing machine automatically.

Loads are measured by Baldwin SR-4 transducers, and output may be fed to printers, converters, typewriters and card punch systems. For full information write Dept. 2223, Electronics & Instrumentation Division, BLH Corporation, Waltham, Massachusetts.


Accommodates bigger specimens
Provides high capacity alternating loads
Operates from strain gage signa

For more information, Circle No. 441

BALDWIN
BLH
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ELECTRONICS & INSTRUMENTATION DIVISION
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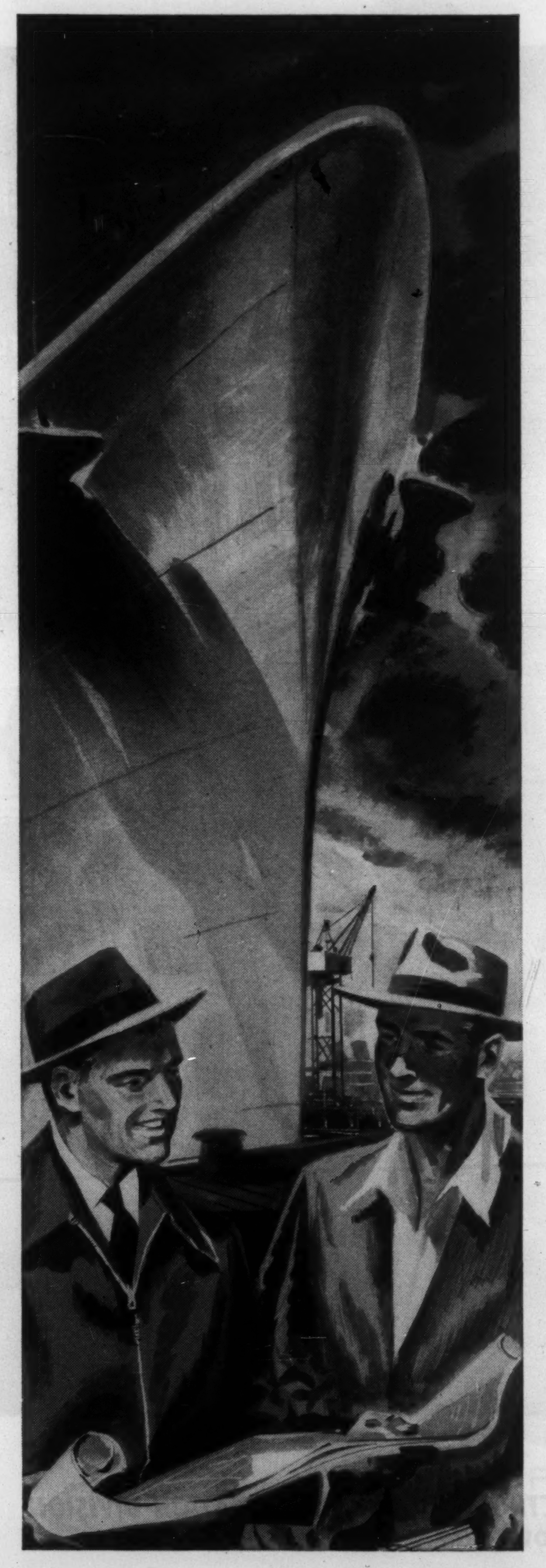
ENGINEERS!

WESTINGHOUSE now offers you immediate opportunities to

solve problems in atomic propulsion



Work in nuclear energy with the company that powered the Nautilus . . . first atomic sub!

NO DELAY IN AWAITING SECURITY CLEARANCE

New ground-floor opportunities are now open at Westinghouse to break into vital atomic work. Join a fast-growing department which purchases, through subcontractors, the atomic equipment needed for submarines and surface craft.

Assignments involve broad responsibility — from preparation of specifications for components, through fabrication and testing, supervising quality, delivery to shipyards, and putting equipment into actual operation.

Westinghouse invites you to join this challenging activity — whether you are a professionally established engineer, or just starting your career. *Relocation allowances* and unique automatic annual salary increase plan, in addition to merit increases.

IMMEDIATE OPPORTUNITIES FOR:

METALLURGISTS AND MATERIALS ENGINEERS — experienced in materials and metallurgical application and development.

SEND YOUR RÉSUMÉ TO:

Mr. John D. Batey, Dept. 191,
Westinghouse Electric Corp.,
P. O. Box 1047, Pittsburgh 30, Pa.

Westinghouse
FIRST IN ATOMIC POWER

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For more information, Circle No. 400 ➤

TECHNICIANS LESTER FILLER (front) and **EVERETT FLOM** prepare to radiograph the internal structure of a vertical stabilizer on a Beech T34A. They're using Triplett & Barton's new 65-lb. portable x-ray unit with Du Pont Type 506 Fine Grain Industrial X-ray Film.

At Triplett & Barton, Inc., Wichita, Kansas:

"We get excellent results on sections ranging from .0002" to 7" thick with Du Pont X-ray Film"

ROBERT E. NASE, Du Pont Technical Representative is a frequent visitor at the Triplett & Barton Lab. Here, at the illuminator, he discusses the interpretation of the radiograph taken above.

Hank Wyckoff, manager of the Triplett & Barton X-ray Laboratory at Beech Aircraft, goes on to say: "We've used Du Pont X-ray Film in all our branches for the past 15 years. During this time we have made over twenty million exposures. We have done more research work with Du Pont's Type 506 than any other industrial x-ray laboratory in the country and we recommend it to our customers on the basis of this research."

You can depend upon Du Pont Industrial X-ray Film to register even the most minute flaw in a part—this dependability results in tremendous savings in man hours, machine time and inspection time. First of all, its good contrast, stability and uniformity simplify interpretation. The blue base cuts eyestrain and the wide latitude helps solve your difficult exposure problems. The packaging without interleaving paper of Du Pont 506 N.I.F.* eliminates darkroom clutter and speeds handling. Holder loading is faster, too. And you always have the services of a Du Pont Technical Representative on any x-ray problem you may encounter.

FOR MORE INFORMATION,

contact the nearest Du Pont Sales Office (listed below) or the Du Pont Company, Photo Products Department, Wilmington 98, Del. In Canada: Du Pont Company of Canada Limited, Toronto.

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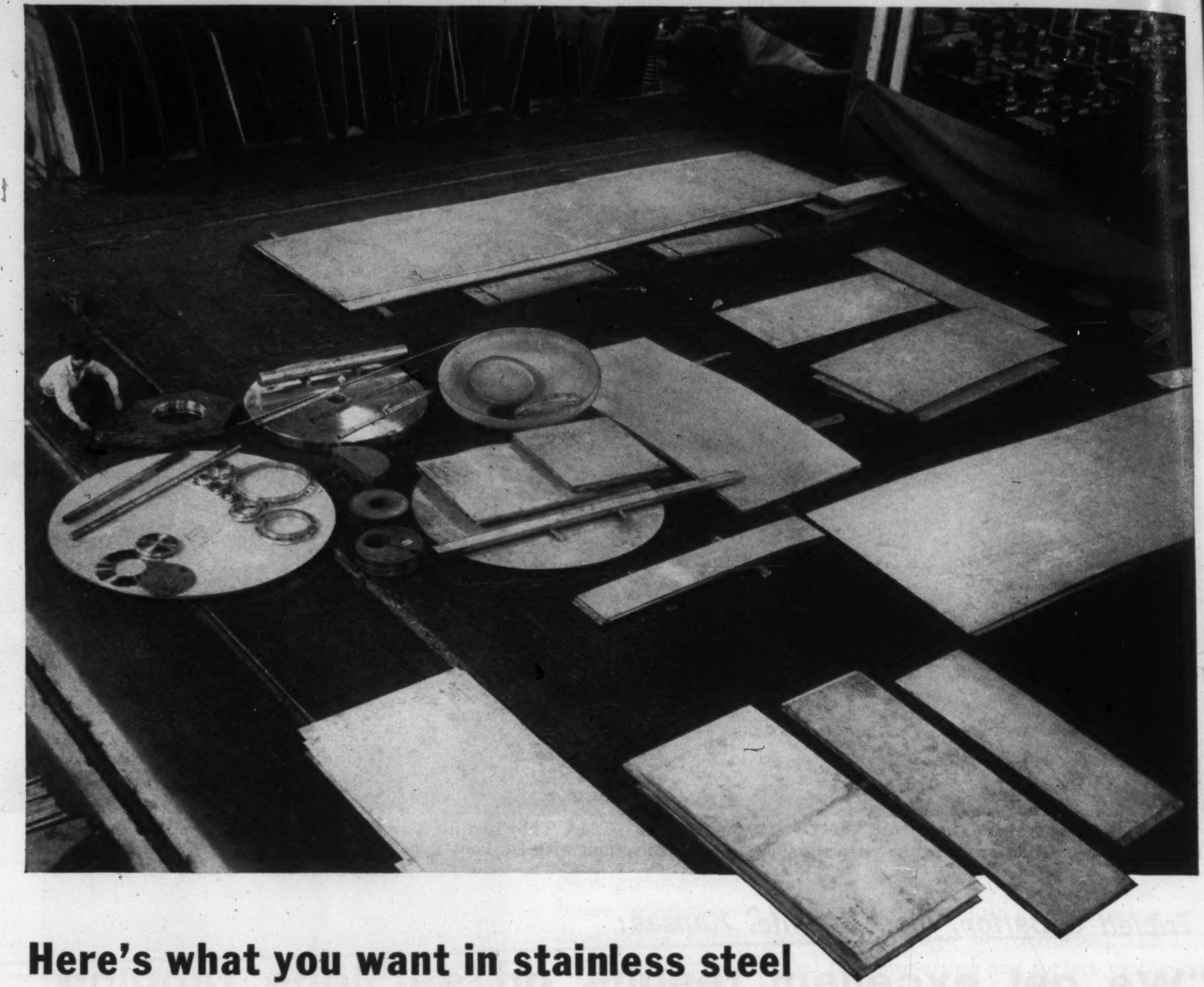
*N.I.F.—Non-Interleaved Film

DU PONT
REG. U. S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING
. . . *THROUGH CHEMISTRY*

DU PONT X-RAY PRODUCTS



Here's what you want in stainless steel —the way you want it

Stainless Steel Plate . . . produced to almost any size or thickness, 3/16″ and heavier, in rectangles or cut-to-shape. Carlson maintains what is probably the largest stock of stainless plate in the country—produced to highest chemical and metallurgical standards—ready for cutting to your requirements, and for shipment when you want it.

Stainless Steel Heads . . . spun or press formed to your order or taken directly from our stock of ASME and Standard flanged and dished heads—the *largest stock* maintained anywhere. In addition to supplying heads for tanks, heat exchangers, condensers and similar equipment, Carlson can fill a complete bill of material including shell plates, flanges, rings, pads and other components.

Stainless Steel Forgings, Circles, Rings, and Special Patterns . . . Flanges, circles, rings, and sketch plates are cut from plate, or forged and rough machined to meet your specifications.

Stainless Steel Bars and Sheets (No. 1 Finish)

Complete Service . . . At Carlson the emphasis is on flexibility, efficiency and economy in producing what you want, when you want it. If you would like additional information about our service and products or if you want *to place an order*—just let us know, we promise you prompt action!

Stainless Steels Exclusively

G.O. CARLSON, INC.

THORNDALE, PENNSYLVANIA

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bearing manufacturer gains over 300% higher yield with Vacuum Metals FERROVAC

Because a leading manufacturer of precision instrument bearings worked to such exacting standards, he experienced an exceptionally high rate of rejection of finished parts. Then they tried Vacuum Metals FERROVAC®. . . of the same basic analysis as the air-melted grade used previously. The results were decisive. Rejections were reduced to less than 1% – a yield improvement of better than three times.

That's to be expected from vacuum-melted alloys, because of their remarkable uniformity. Gases that cause inclusions and that in turn lead to rejection – or early bearing failure – are literally sucked from vacuum-melted alloys during production . . . before the metal becomes solid.

The result is a *clean* alloy – with many of its properties improved. It is stronger, tougher, far more resistant to wear and fatigue. It works longer and harder than conventionally-melted alloy – even does the super-tough jobs where *nothing else* will work.

Only Vacuum Metals gives you one-source service – Vacuum Metals' own large organization, and its affiliation with National Research Corporation and Crucible Steel Company of America, brings you a fully integrated service. It includes everything from melting and casting, through mill rolling and nationwide distribution of finished products. If you have an application where you can use vacuum-melted metals – in experimental lots or production quantities – Vacuum Metals can serve you. Write us now, outlining your requirements. *Vacuum Metals Corporation, P. O. Box 977, Syracuse 1, New York.*

VMC

VACUUM METALS CORPORATION

Division of Crucible Steel Company of America

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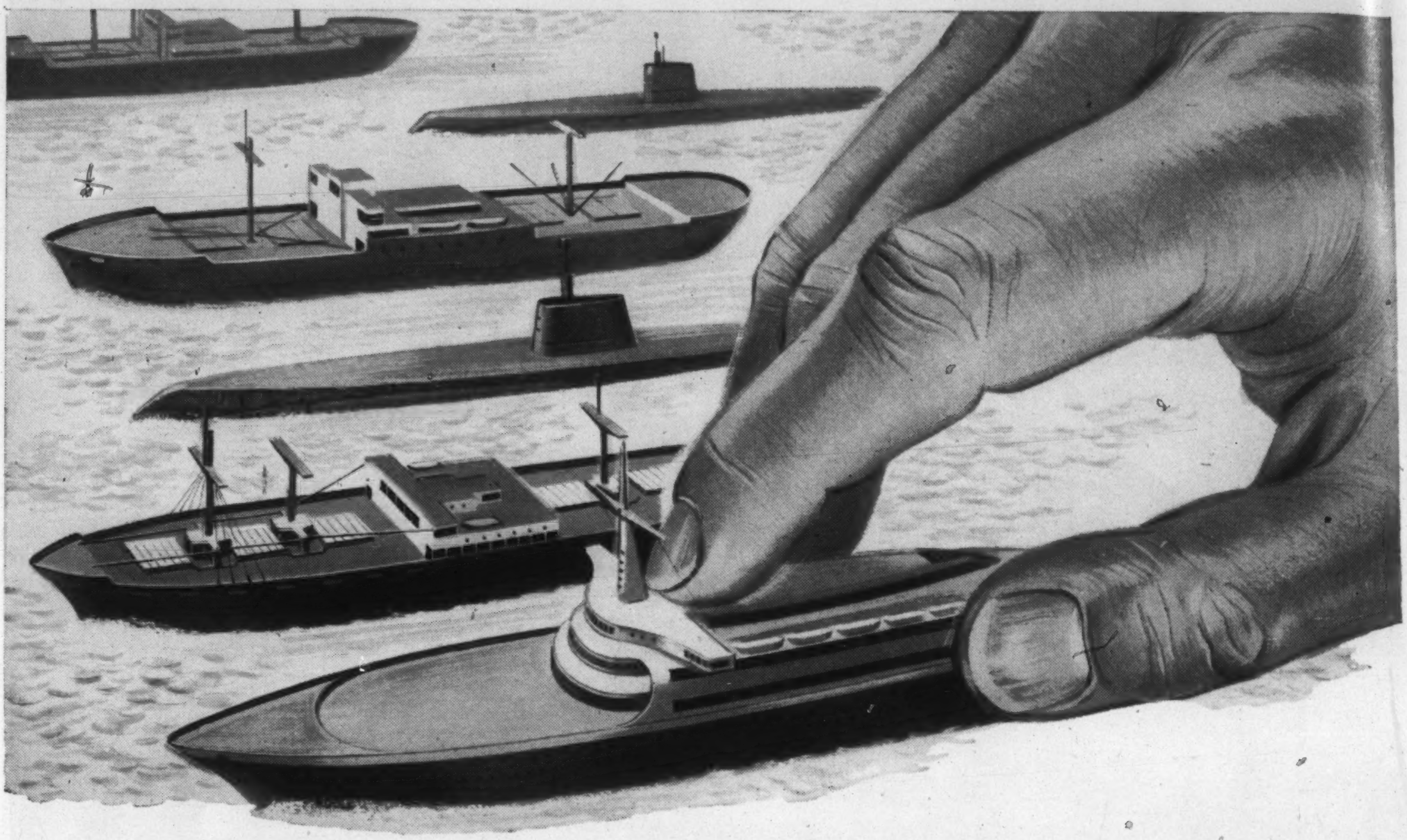
METALLURGISTS...



Help develop the world's first nuclear powered fleet

Nuclear power offers tremendous advantage for naval vessels. From the fuel standpoint, cruising ranges are virtually unlimited—even at new high speeds. No refueling facilities will be required to replenish nuclear propulsion fuel. Therefore, the physical design of the fleet can be streamlined for greater efficiency and safety.

At the country's largest design-engineering center for nuclear power reactors, Bettis Plant in Pittsburgh, operated for the Atomic Energy Commission by Westinghouse, the application of nuclear power has progressed rapidly. However, the nuclear power plants already in operation today represent only the beginning of a new technological era. *Major advances in many areas are necessary.*

These include: the development of fuel alloys; the development of clad alloys; fuel element development; and technical control of fuel elements and fuel and clad alloys. At Bettis you will have a choice of working in either Basic or Applied Metallurgy. You may prefer to conduct basic research in areas like these: 1) Solid phase transformation, 2) Corrosion kinetics and mechanisms, 3) Effect of irradiation on metals, 4) Internal friction studies, 5) Study of equilibrium diagrams.

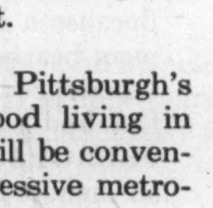
To do this, Bettis Plant needs farsighted men. Regardless of your interest, you can choose a place in the varied operations at Bettis Plant.

Atomic experience is not necessary.

What's more, Bettis Plant is in Pittsburgh's South Hills. Here you can enjoy good living in pleasant suburbs near the plant, and still be convenient to one of the nation's most progressive metropolitan areas.

Educational opportunities are exceptional. Westinghouse helps you continue your studies at any one of three Pittsburgh universities.

Write for descriptive brochure on opportunities in your field. Be sure to specify your interests. Address Mr. A. M. Johnston, Westinghouse Bettis Plant, Dept. A100, P. O. Box 1468, Pittsburgh 30, Pa.



BETTIS PLANT

Westinghouse

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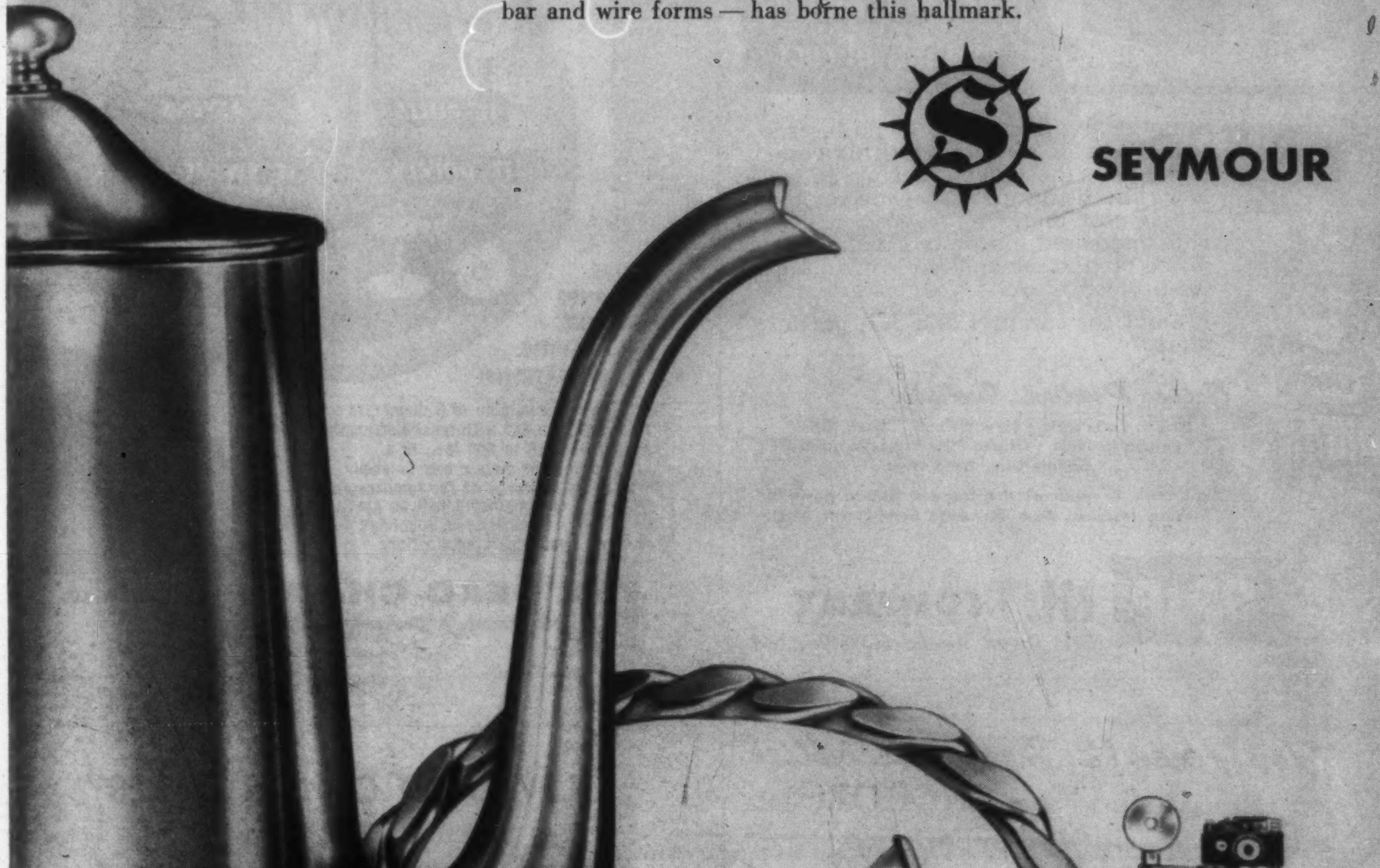
NICKEL SILVER — enduring and malleable — is an inherent part of the finer things of life. In richly plated dining ware; in costly costume jewelry; in top-performing motorcars; in precision-made cameras, optical goods and scientific instruments, this wonderfully stable and versatile alloy plays an essential role . . .

For nearly eight decades, America's finest nickel silver — in sheet, strip, bar and wire forms — has borne this hallmark.

SEYMOUR



THE SEYMOUR MANUFACTURING COMPANY • SEYMOUR, CONNECTICUT, U.S.A.

for the finest Nickel Silver — Phosphor Bronze — Brass.

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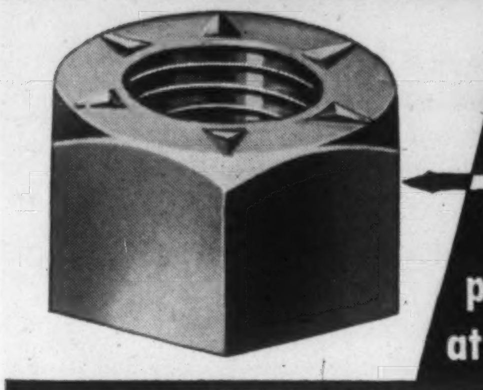
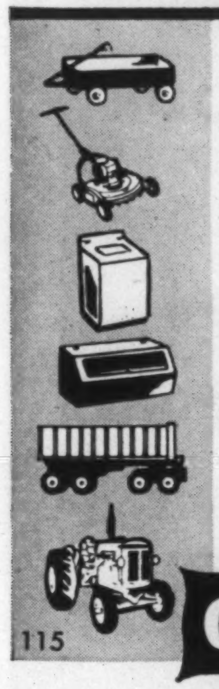
SPECIFY GRIPCO LOCK NUTS



to resist stress, wear and vibration

They increase product durability at low initial cost



Simple one piece design — no inserts — no outside devices. Nothing complicated — the Gripco locking action is within the nut itself, yet you get low initial cost and low application cost with increased customer satisfaction. Speed production and lower manufacturing costs on your products now.

Send for samples and full particulars.

Gripco Products Include:

Gripco Lock Nuts • New Gripco "Clinch Nuts"
Gripco Hi-Nuts • Gripco Pilot-Projection and
Countersunk Weld Nuts

all with or without the famous Gripco positive locking feature. Also Standard Semi-Finish Nuts.

GRIP NUT COMPANY
101 Broad St. • South Whitley, Ind.

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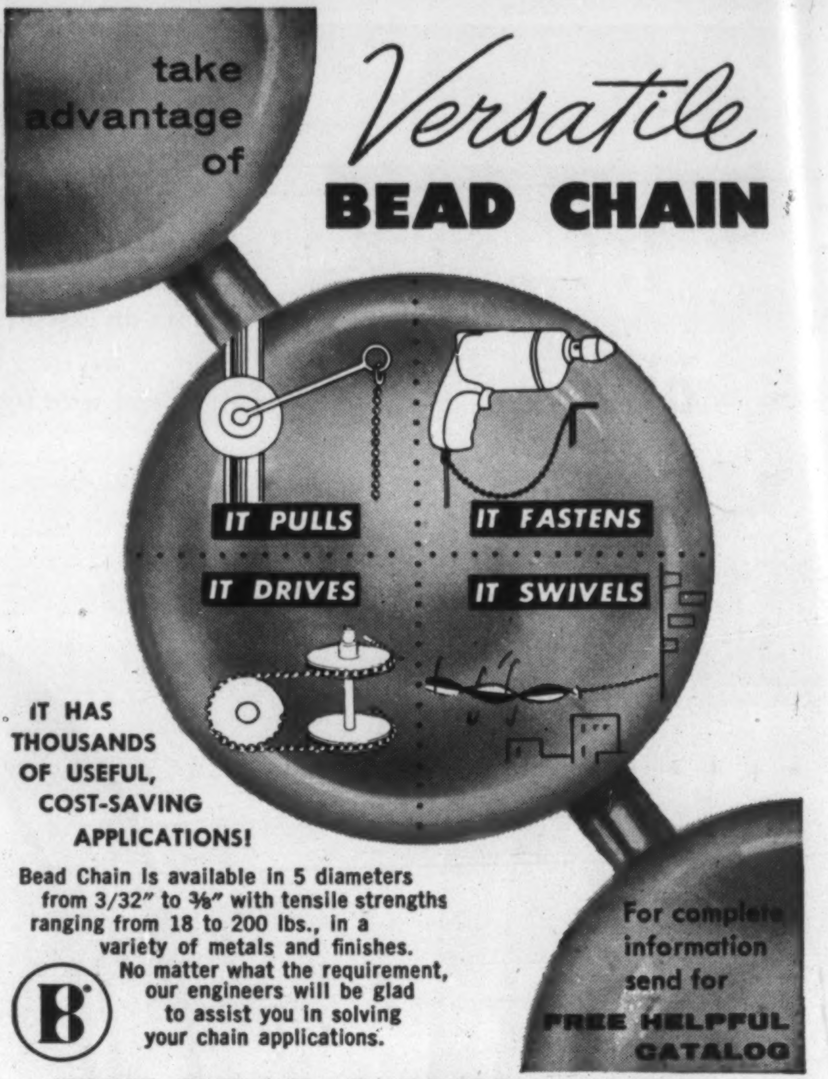
take advantage of *Versatile*

BEAD CHAIN



IT HAS THOUSANDS OF USEFUL, COST-SAVING APPLICATIONS!

Bead Chain is available in 5 diameters from 3/32" to 3/8" with tensile strengths ranging from 18 to 200 lbs., in a variety of metals and finishes. No matter what the requirement, our engineers will be glad to assist you in solving your chain applications.

For complete information send for FREE HELPFUL CATALOG

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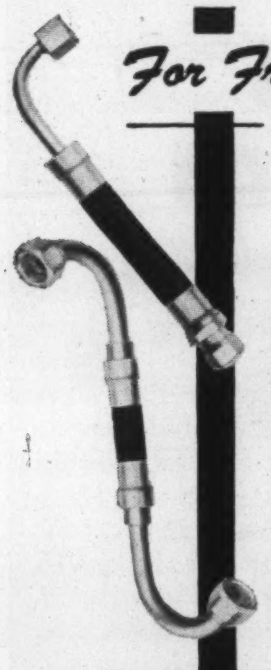

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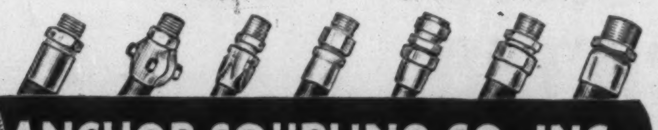

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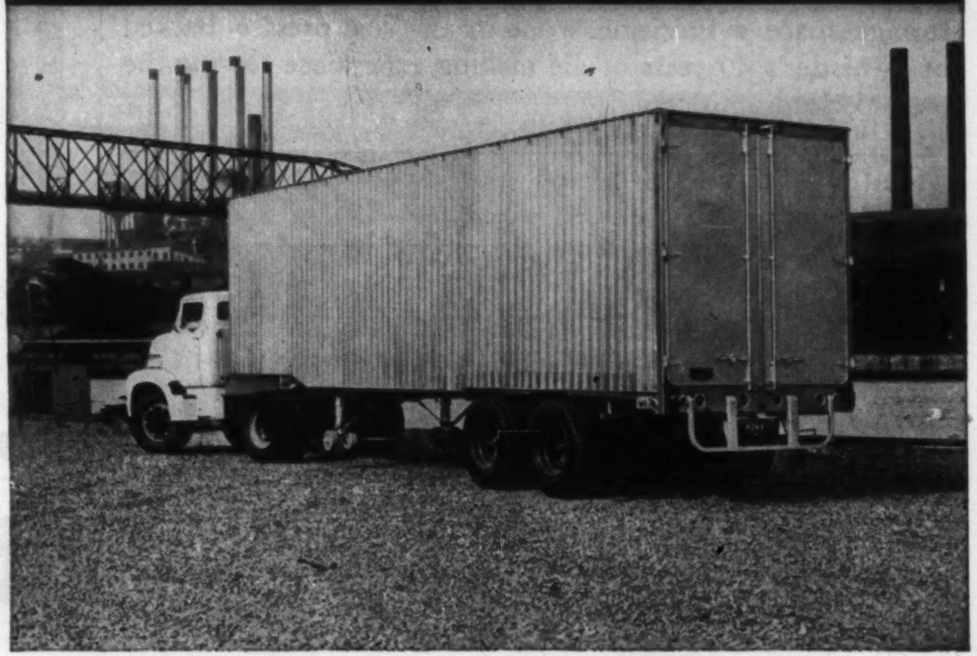

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In the top photograph, the fabrications you see are a mixing bowl, a tea-kettle base, a lock case and a patented shoe fastener: all made of A-L Type 201 or 202 chrome-manganese low-nickel stainless. The finish is good, the steel handled the same in the presses as Types 301 or 302, and similar drawing, buffing and polishing procedures were followed.

As in the lower illustration, the chrome-manganese low-nickel grades are being used also for fabrications as large as truck trailers and railroad coaches. Again, forming qualities and weldability present no problems, and results are entirely satisfactory.

Sum it all up and this is the answer: you *won't* encounter any particular differences in fabricating the 200-series of stainless steels . . . you *will* find some advantage in price, and a very important factor of much greater availability in times of nickel shortage. ● Why not take advantage of our pioneering experience with the low-nickel grades—let us help you use them. *Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.*

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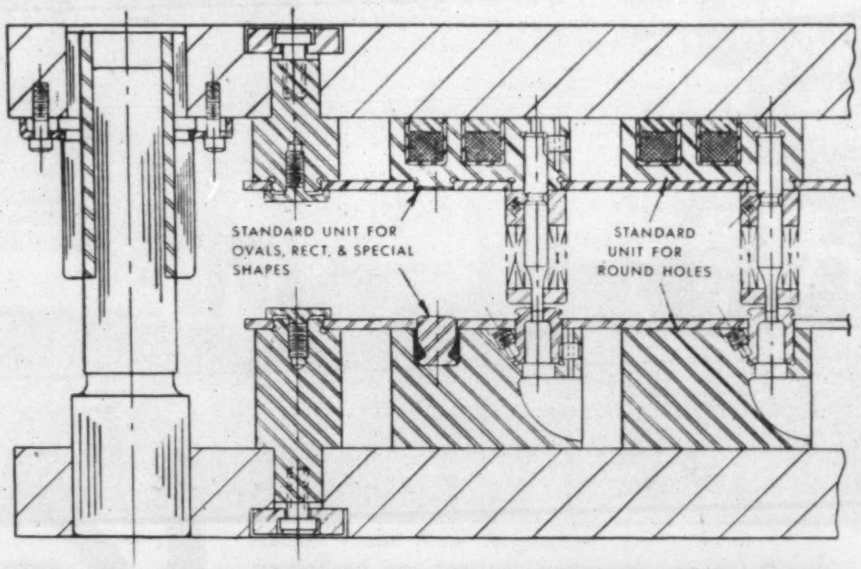
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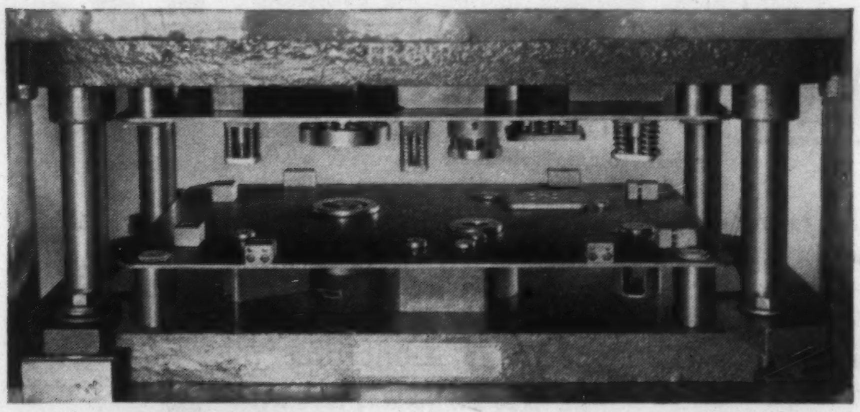

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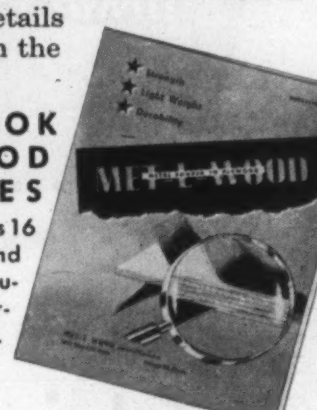

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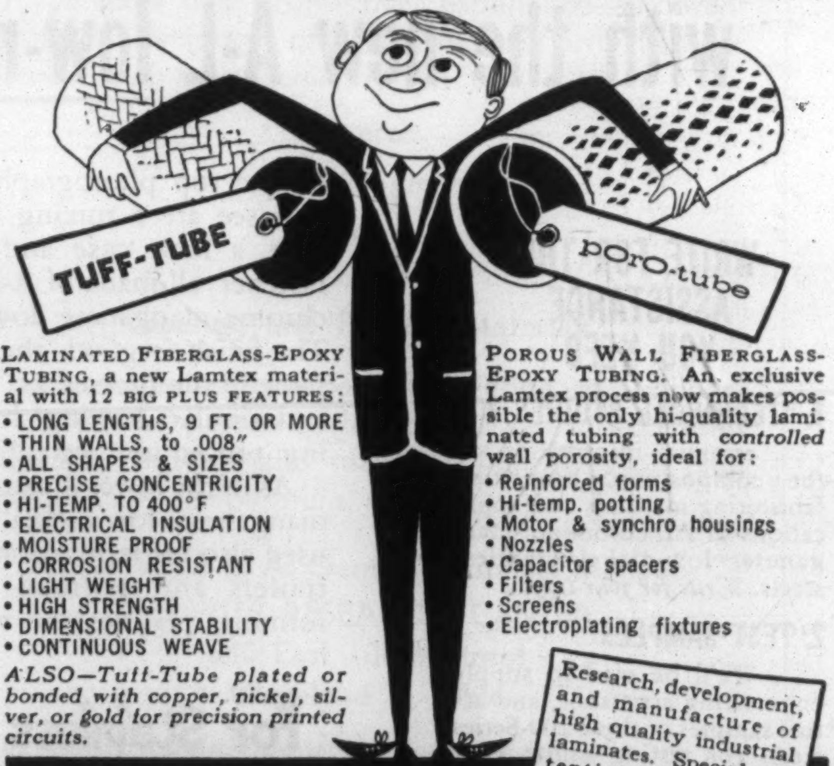

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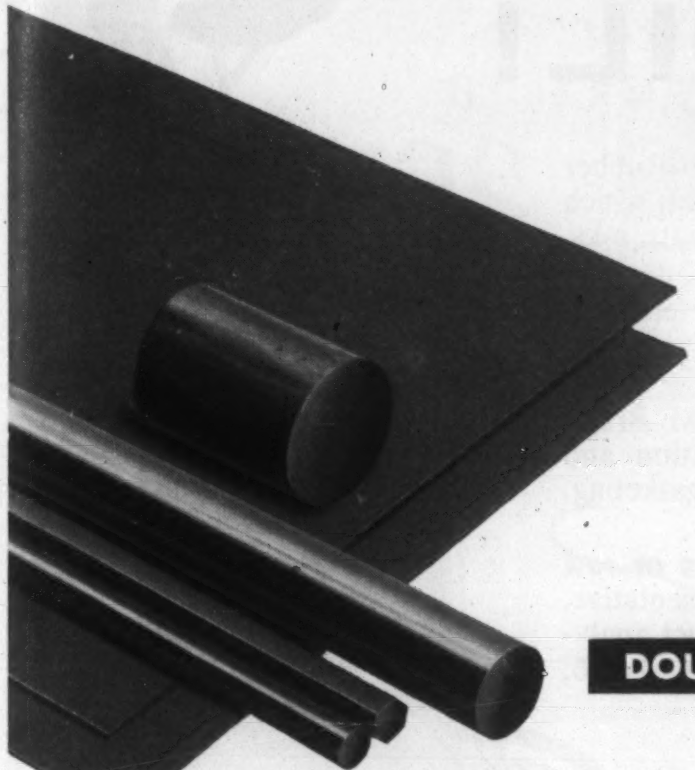

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MST 8 Mn—An alpha-beta sheet alloy used primarily in the annealed condition. It has good formability and may be used at moderately elevated temperatures in the annealed condition. Eutectoid decomposition is so sluggish that it does not occur in commercial applications.

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	Form	Ultimate Tensile Strength, psi	Yield Strength, psi	Elongation % in 2″
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(3 different strength levels) .	Sheet, Bar	85,000	65,000	23
	Sheet, Bar	100,000	80,000	20
MST 6Al-4V (1)*	Bar	140,000	130,000	13
(2)	Bar	170,000	150,000	12
(3)	Bar	135,000	125,000	12
(3)	Sheet	130,000	120,000	12
MST 3Al-5Cr	Bar	155,000	145,000	13
MST 4Al-4Mn	Bar	145,000	135,000	14
MST 8 Mn	Sheet	135,000	120,000	15

* (1) 1500—½—AC
(2) 1750—½—WQ, 1000-2-AC
(3) 1525—1—FC to 1100-AC

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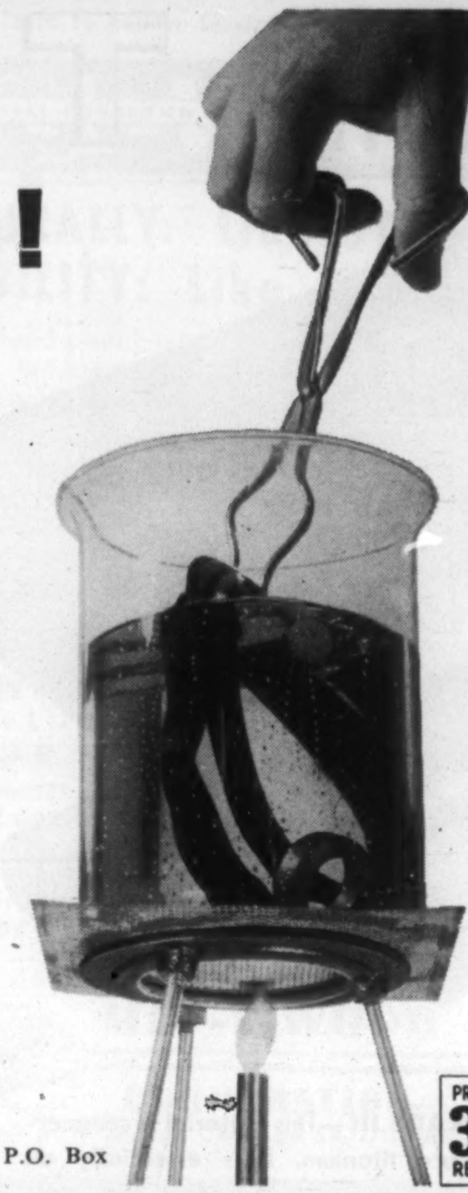

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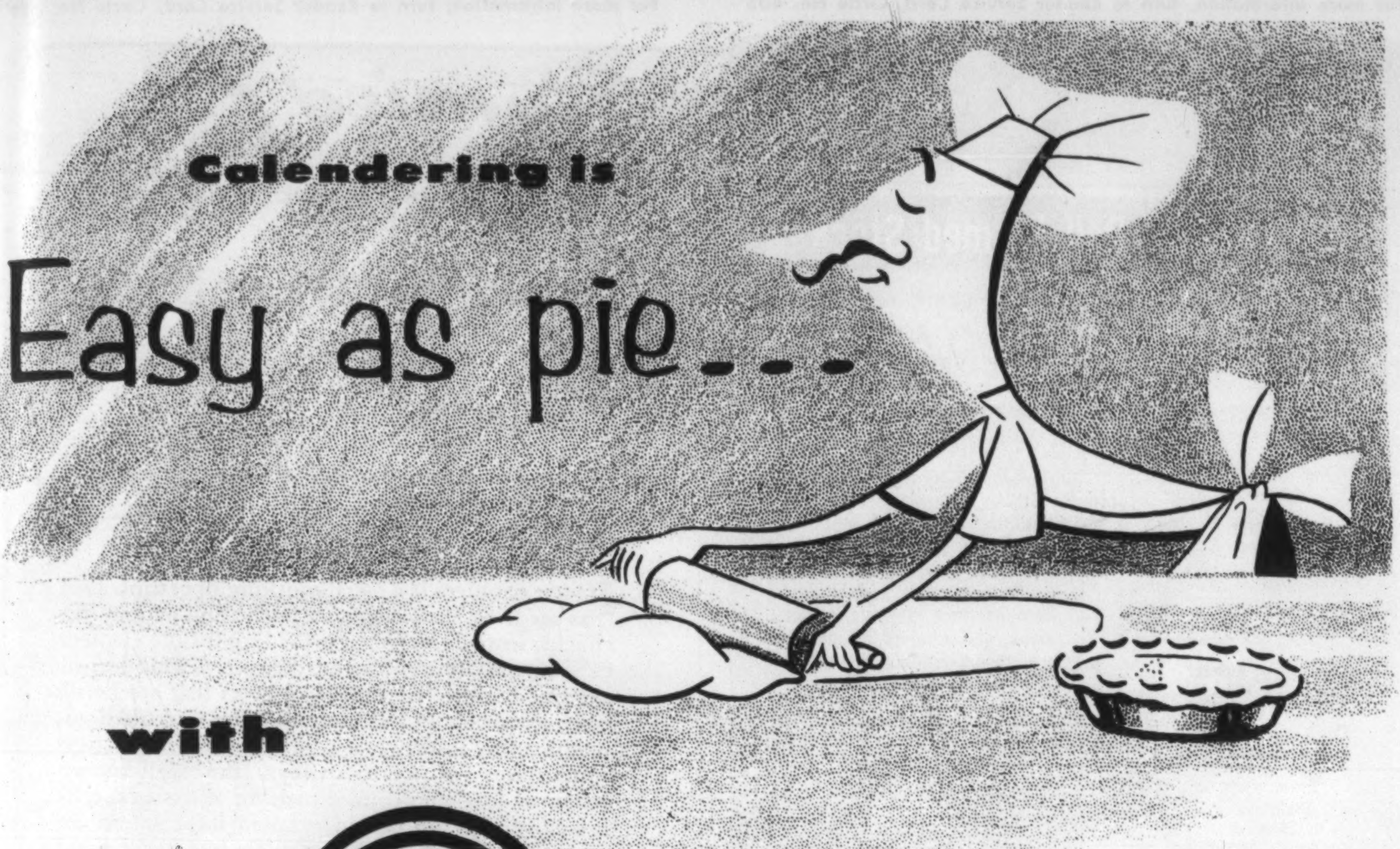

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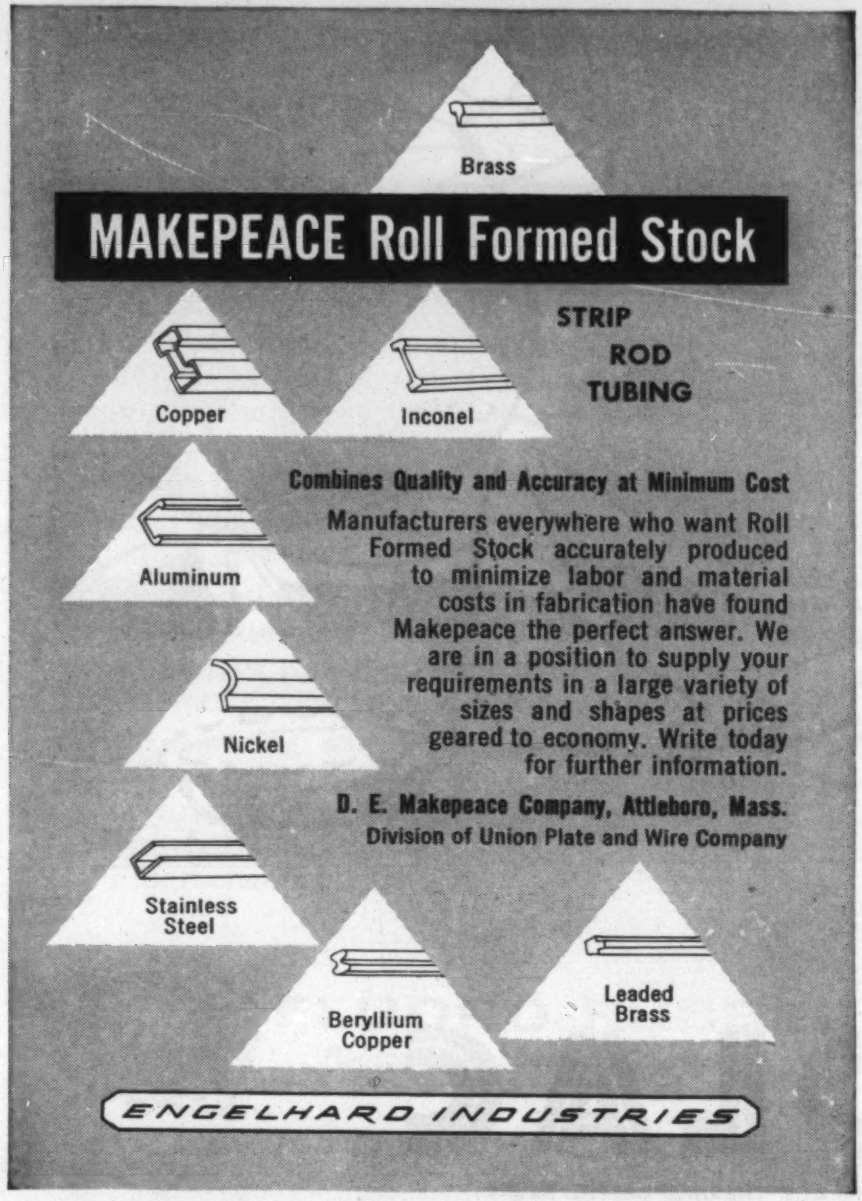

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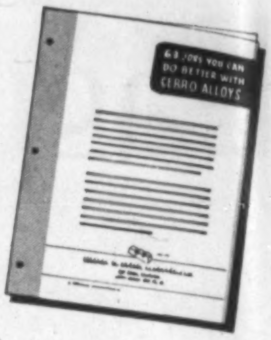
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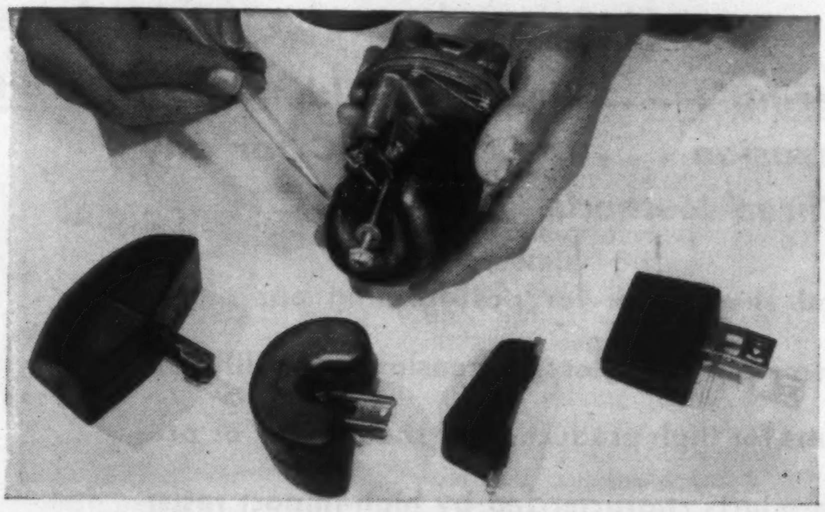

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for high heat or other severe conditions

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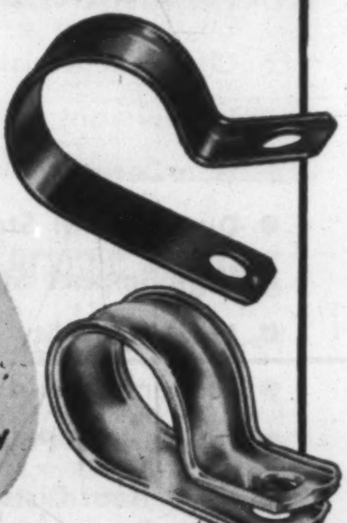

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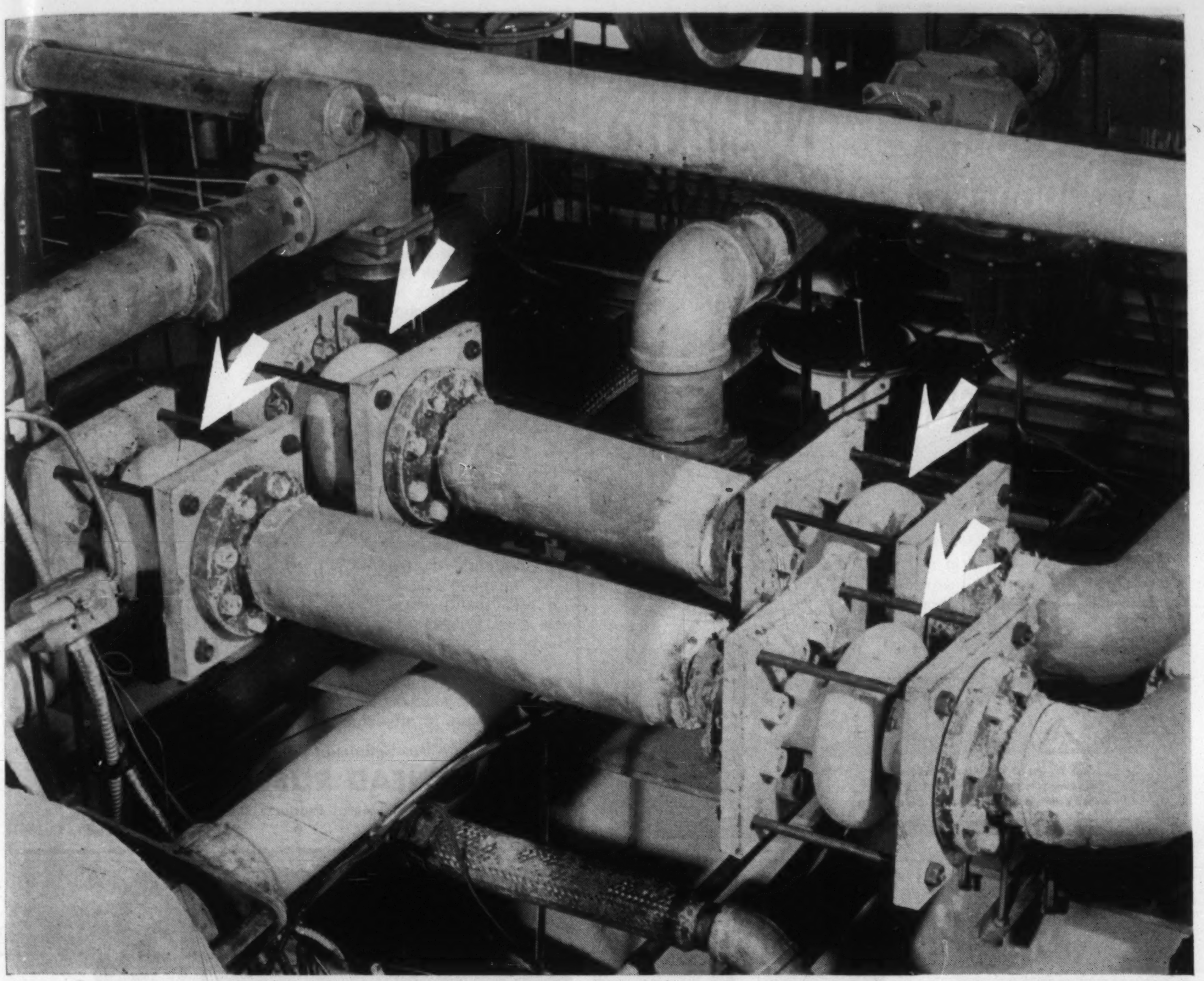

"Only *Carpenter* Stainless Tubing gives us failure-proof service"

The manufacturer of these four truly maintenance-free packless expansion joints (shown by arrows, above) has tried other stainless tubing, but says Carpenter Stainless Tubing is the "only one that renders failure-proof service".

These joints absorb thermal expansion, operating at pressures up to 210 psi and temperatures up to 650°F. They are typical of expansion joints made from Carpenter Tubing which operate at pressures up to 10,000 psi or temperatures as high as 1800°F. Once installed, they have never been replaced. Some have been in service over 15 years. The quality and uniformity of Carpenter Stainless Tubing contributed greatly to the trouble-free fabrication and maintenance-free service of these joints.

If an extra measure of quality in stainless tubing and pipe can improve your products or operation, call your Carpenter Distributor. He's your nearby source of better stainless tubing and pipe.

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Carpenter

more than corrosion resistance

Stainless Tubing & Pipe

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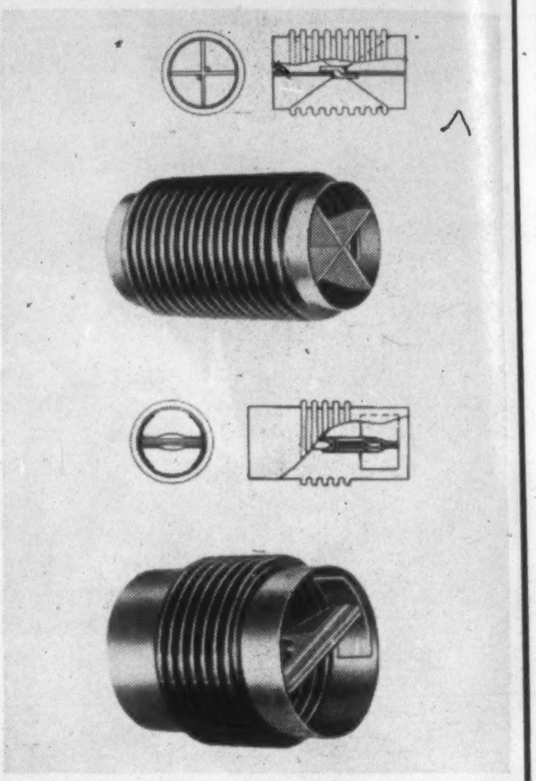
BELLOWS TIE-RODS CONTROL THERMAL GROWTH



These internally restrained stainless steel assemblies are used to control the growth of thermal loads in pneumatic ducting systems by angular deflection. Two kinds are available: a center link type and a double link bar type. The first anchors the ends of the bellows at a single point along the bellows center line; the double pivot type employs two pivot points on the bellows center line. In a tension system these tie-rods reduce the bending moments, reduce the column loading and reaction loads at the mounting flanges.

A complete line of aircraft quality stainless steel bellows and ducting components are manufactured by Arrowhead. Other products include pressure compensating chambers, braided-bellows and flexible rubber-fiberglass ducting. Bellows are made in all diameters from 1″ to 15″.

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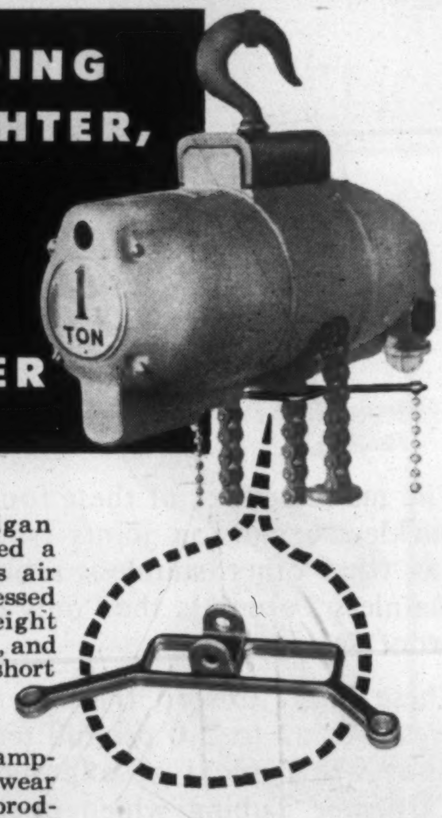

A Grand Haven, Michigan manufacturer formerly used a cast control lever on his air hoists. Converting to a pressed steel stamping saved weight without sacrificing strength, and allowed him to order in short run quantities.

Dayton Rogers' small lot stamping service saves money, wear and weight, and improves product usage. Our facilities will handle blanks 22″ square; material up to 3/8″ thick; and draw operations up to 4¼″ deep.

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"To Err is Human..."

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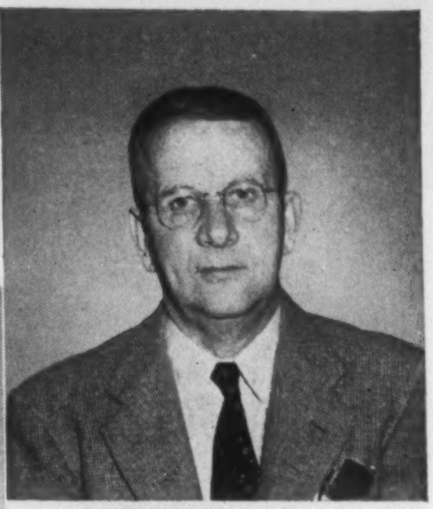
43 years

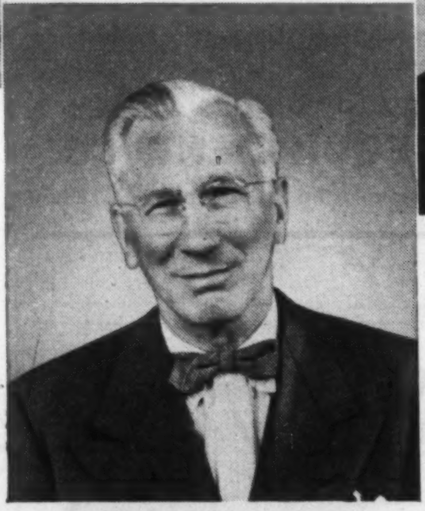
Lewis Held
Vice President
21 years

Thomas J. Walker
Controller & Secretary
21 years



Hans Hanson
Die Room Supervisor
40 years

Vincent Saracco
Eng. Asst. to V. P.
15 years



George Newberg
Tool Room Supervisor
32 years

– but when we've made mistakes at Mt. Vernon, it's the customer who benefits

If there lives a man who has never made a mistake—it's because he has never had the courage to try anything new.

The 6 men pictured here are the men to whom you entrust your work when you hire Mt. Vernon to do it. The total of their experience in die casting adds up to 172 years.

Each of them is exceedingly human—and each of them would be the first to admit that he has made some mistakes. But in doing so, he has learned better ways of giving you ever finer die casting, at ever lower cost to you.

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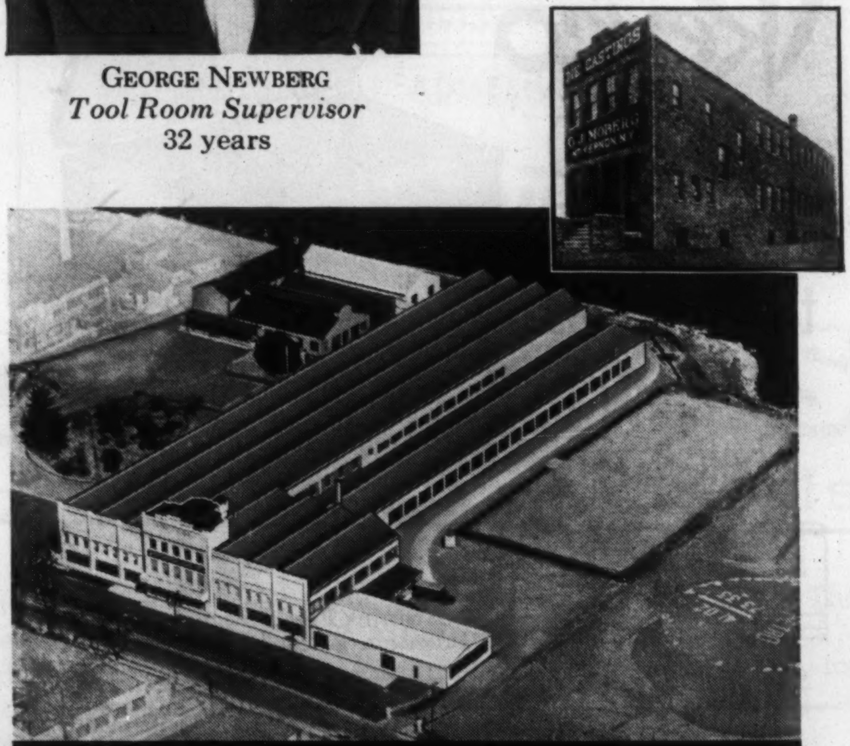

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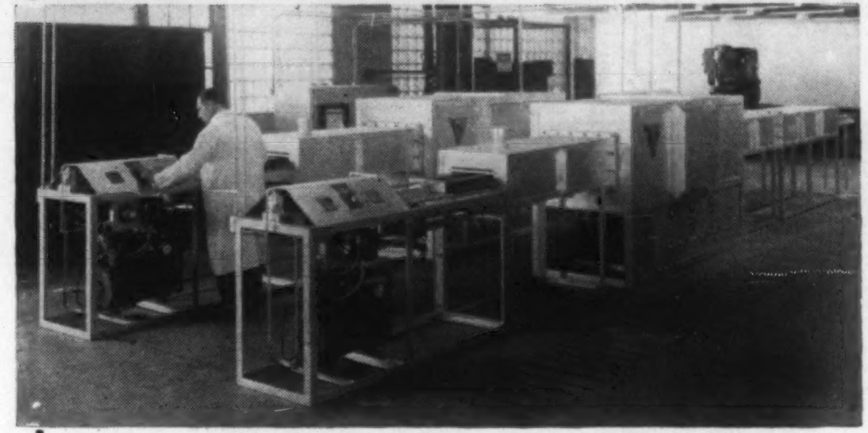

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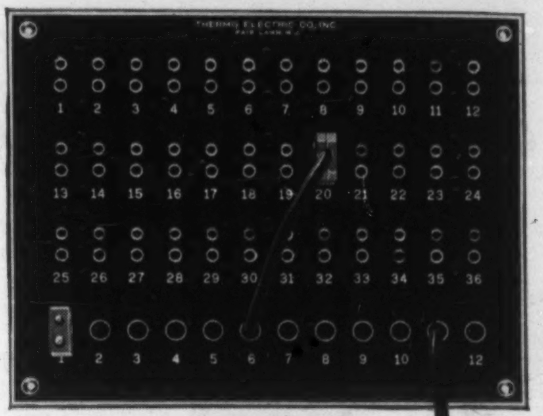

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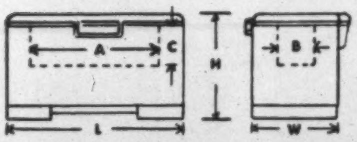

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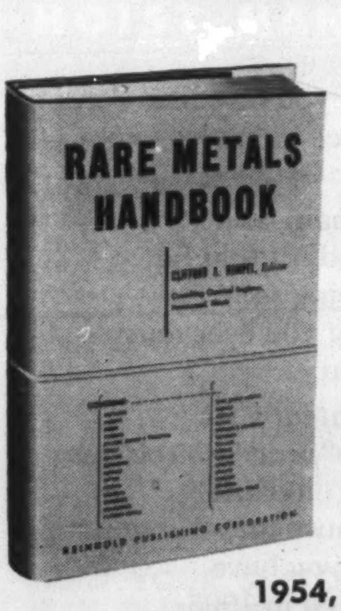

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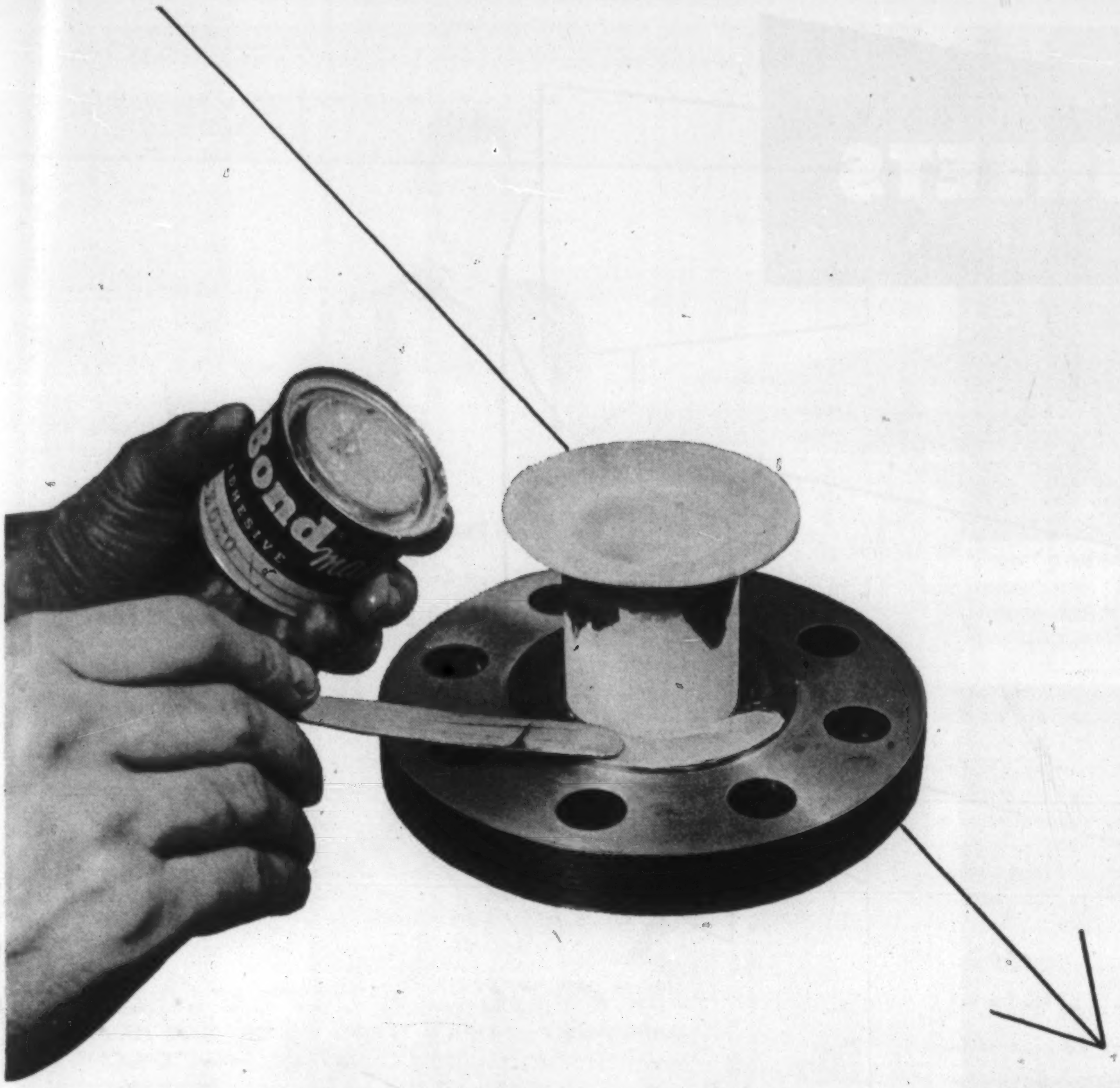

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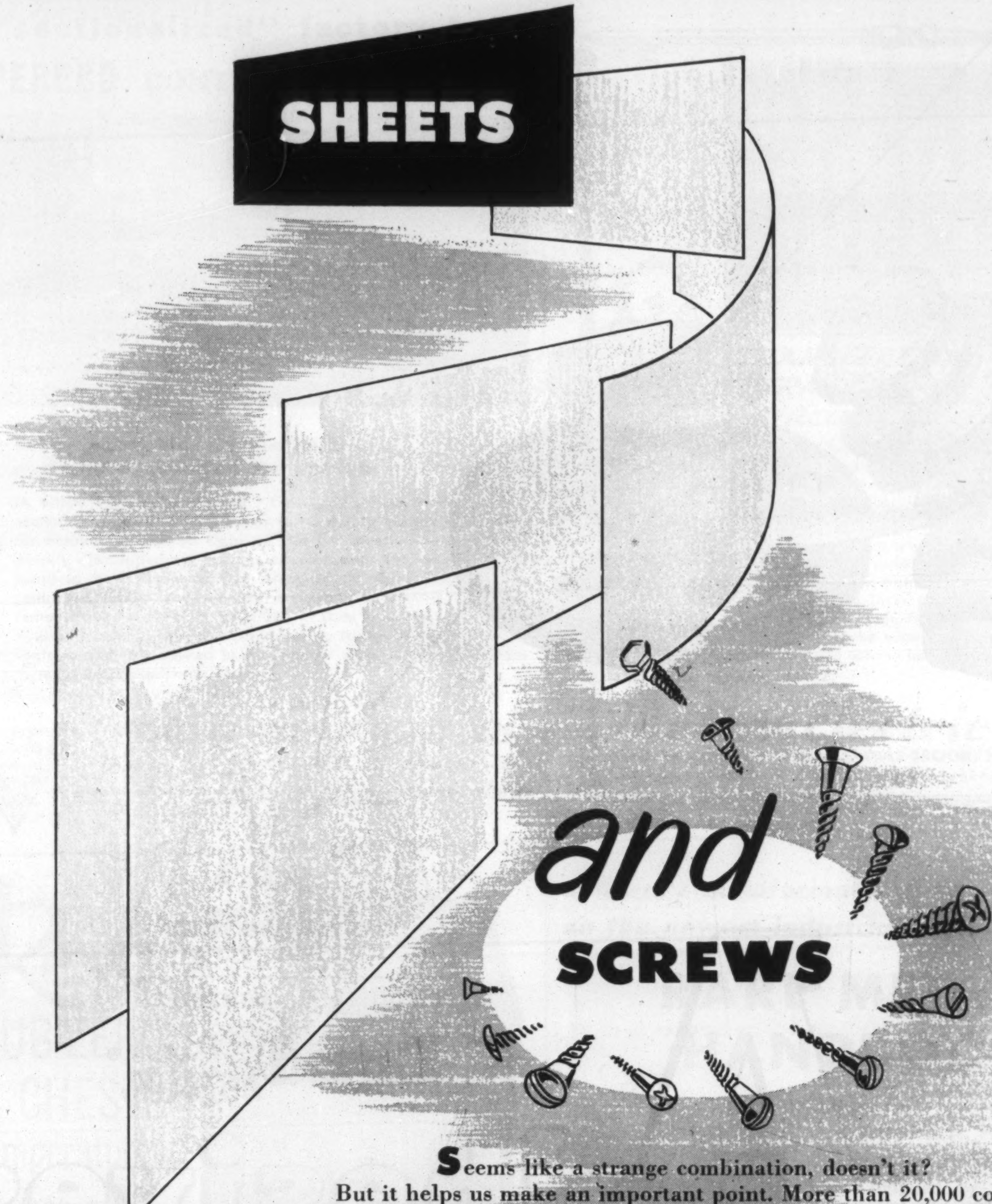

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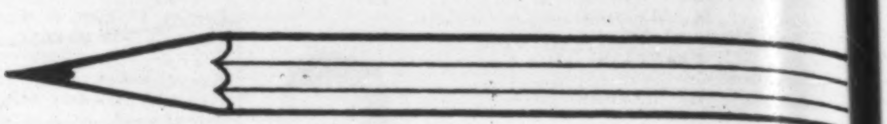

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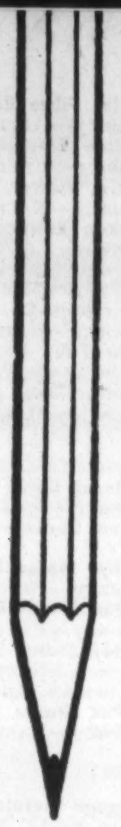


the last word

Something Different, Something New

We are full of new projects and changes for MATERIALS & METHODS these days. You have read in "One Point of View" and on page 115 about our Awards Program. And next month you will see a number of signficant changes in the content and arrangement of our regular editorial departments.

But perhaps the most important new venture of all is the reference issue we are now preparing for publication next fall. It will be called the "Materials Selector for Product Design" and you will receive it as part of your regular subscription.

The Selector is designed to provide maximum help to you in picking the right materials for your products. There will be a Selection Guide composed of over 200 pages of data and information organized to match the procedures generally followed in selecting engineering materials. One section of data sheets will compare the engineering properties of many different materials. A second section will contain data sheets listing properties of specific materials. And a third section will present design data and characteristics on the many different forms in which materials are available.

In addition to these three data sections, there will be a Buying Guide in which suppliers of engineering materials, parts and finishes will be listed. To us it is a most exciting new project, and if our preliminary reader opinion survey is correct, you, our readers, will find it extremely worthwhile.

Beware Ladies' Night

How trusting and foolhardy can men be? The Metropolitan Section of the Electrochemical Society has just completed elaborate plans for a ladies' night program, and invitations to all wives will soon be in the mails. But despite all of their well laid plans, we have detected one deadly flaw in the evening's festivities. The dinner speaker's subject will be Poisonous Materials.

Newspaper Gleanings

The headline on a story about the star of Pittsburgh's pro football team:

"Nickel of Steelers Is Made of Iron."

—*N. Y. Times, Oct 19, 1956*

The first sentence of a columnist's description of his visit to a camera factory:

"I recently visited a camera factory on Long Island which stamps out its own metal castings, yet I heard very little pounding."

—*N. Y. World Telegram & Sun, Oct 25, 1956*

HRClauser

Editor

sing

DU PONT ELASTOMERS
NEOPRENE • HYPALON®
in Design

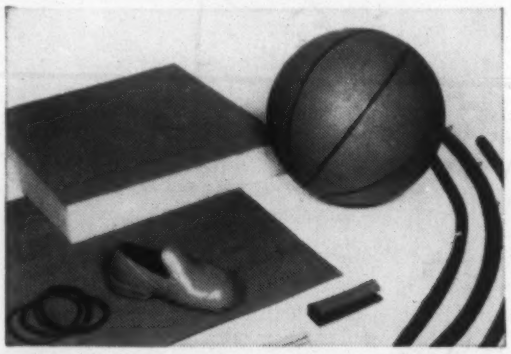
Coatings of HYPALON® add beauty and durability to a variety of products

DuPont's new synthetic rubber, HYPALON, can now be applied as a protective coating on rubber, metal, wood or fabrics. It can be applied by spraying, brushing or spread coating. The development of these coatings, both clear and colored, has opened new avenues of product design in a wide range of applications. Here are the advantages such coatings offer:

HYPALON is unaffected by ozone. It has unusual resistance to hardening at elevated temperatures (250°-350°F.). It is unique in its resistance to weathering and oxidizing chemicals. And, in addition to the protective benefits of HYPALON coatings, an unlimited range of stable colors is available to add beautiful and functional color to your products.

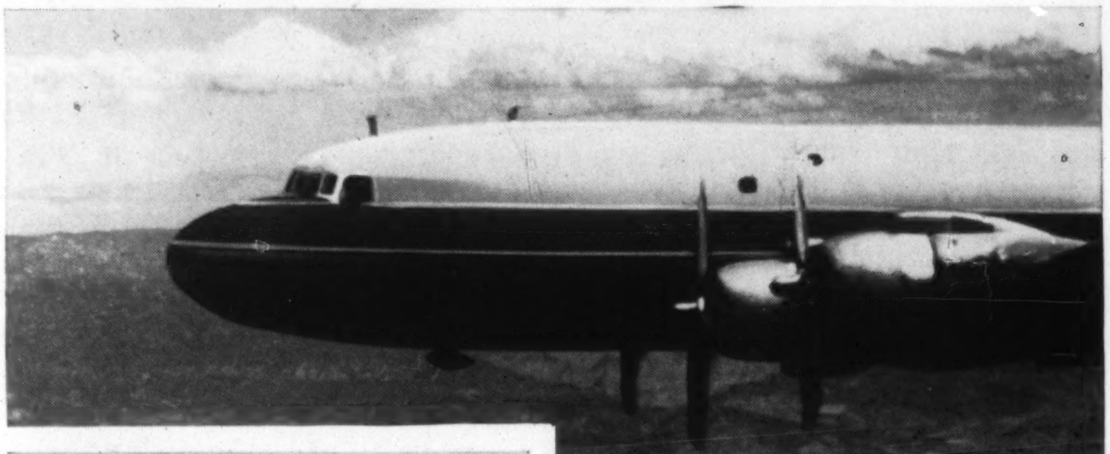
Applications for HYPALON coatings include tank linings, footwear, tarpaulins, camera bellows, hose, belts and automotive and sporting equipment. For other uses see the photograph below.

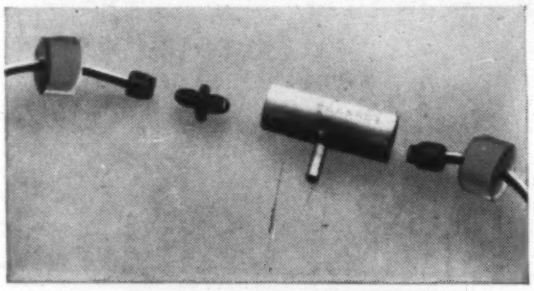
How can coatings of HYPALON fit into your design problems? Mail the coupon for more detailed information about your specific problem.



These products feature attractive protective coatings of HYPALON: a piece of corrugated rubber mat (left foreground); a coil of electrical wire, and a child's overshoe on the mat; rubber extrusions for automobile windshield frame and trunk weatherstripping (center foreground); door weatherstripping (right foreground); slab of urethane foam (left rear); basketball (right rear).

NEOPRENE SEALS safeguard fuel line connections in the Douglas DC-7





SEAL READY FOR ASSEMBLY

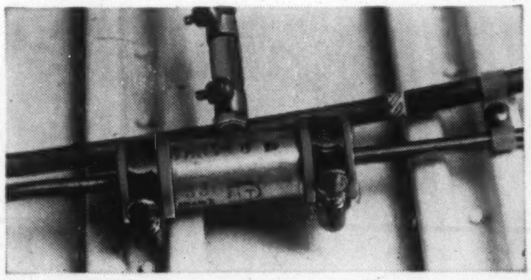
Safety of passengers is uppermost in the minds of Douglas Aircraft designers—even down to as small an item as the rubber sleeve on a fuel line connector. Douglas uses the best metal connectors to join its fuel lines, but as an additional safety factor the company fits a vapor-tight sleeve seal over each joint which is vented by tubing to the ship's exterior to prevent any possible accumulation of highly flammable gasoline vapors within the fuselage.

Before switching to neoprene, Douglas had a problem with the seals. They required frequent replacement because ozone caused the rubber to crack. In fact, many of the rubber seals were rejected as unusable before installation because of ozone cracks which developed while the pre-assembled units were held in stock.

The installation of neoprene seals proved to be the answer to the problem. Neoprene was chosen because it resists ozone, gasoline, oil and aging. Many of the neoprene seals have been in service for over two years, reducing maintenance and replacement costs.

Perhaps your design problems can be solved by the use of Du Pont neoprene. We'd be glad to send you further information—property data and proven applications. If you have a specific problem, please let us know in the coupon.

NEOPRENE SEALS (in red) resist ozone, oil, gasoline and aging. Many of them have lasted for over 2 years.



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HYPALON *is a registered trademark of E.I. du Pont de Nemours & Co. (Inc.)*

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☐ Please add my name to the mailing list for your free publications, "The Neoprene Notebook" and "Facts about HYPALON."

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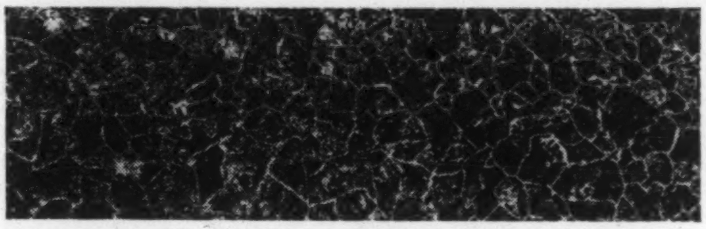
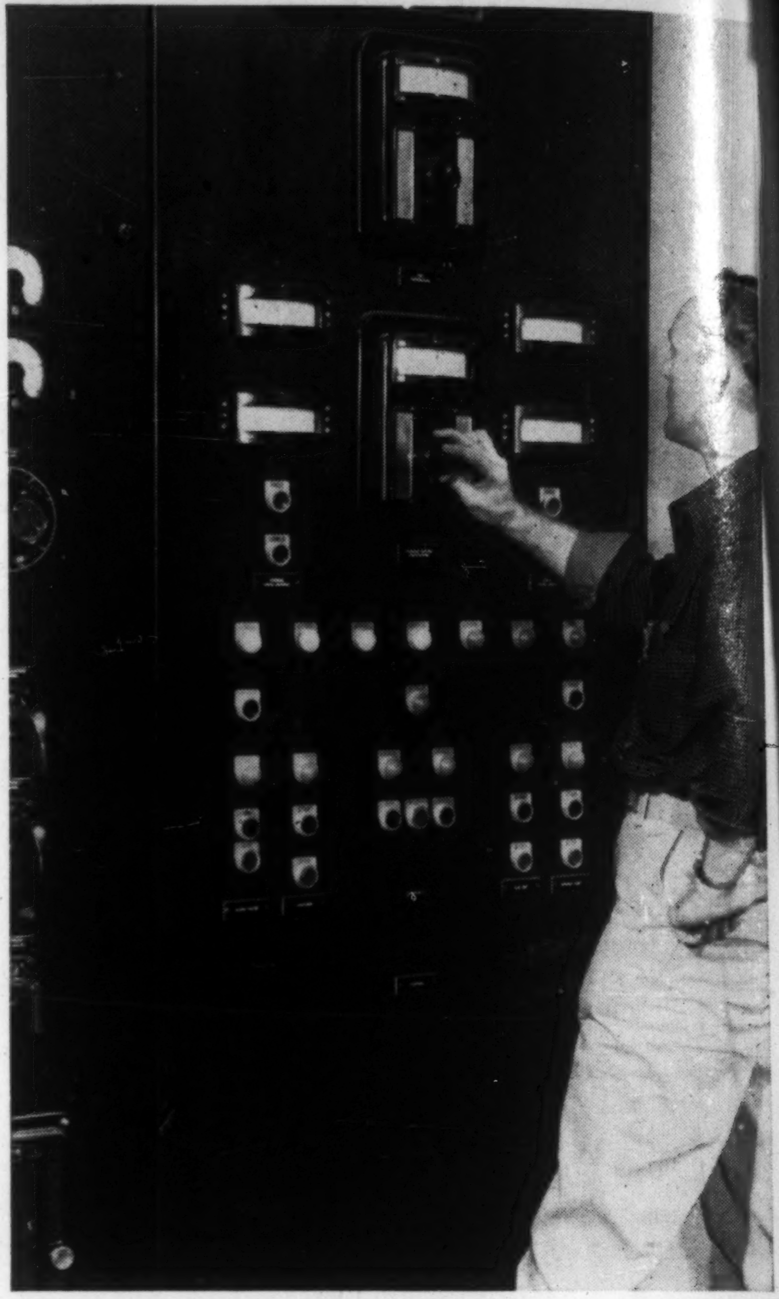
For more information, turn to Reader Service Card, Circle No. 449

He stirs molten steel by magnetic control to help give TIMKEN® forging steels



uniform grain size



WITH the mere turn of a dial, the man pictured here stirs molten steel in one of our huge electric furnaces. He's controlling a magnetic stirrer that assures equal distribution of alloys, uniform temperature and improved working of the slag . . . one of the quality control operations that helps give uniformity to every bar of Timken® forging steel.

Conventional stirring is done manually with a long stirring rod. This new method does it with a travelling magnetic field set up by coils under the furnace. It's the first installation of its type in the United States. And it's another example of the Timken Company's continual search for equipment that will improve steel quality and keep it uniform.

For instance, note the uniform grain size of Timken forging steel in the photomicrograph above. We use the most modern steel-making techniques known to get this uniformity in our steel. And we examine every heat to be sure it's there. Result: you can be sure that your forgings made from this steel have uniformly high ductility and resistance to impact.

To further assure uniformity in your forgings, fewer changes in your forging procedures, your order of Timken forging steel is handled *individually.* This allows us to target our conditioning procedures to your end use requirements. In every lot you order, you get the same physical and chemical properties that you require—bar to bar, heat to heat, order to order. And helping to lower your production costs, the close dimensional tolerances of Timken forging steels produce uniform weight multiples with a minimum of steel lost in flashings, saving you steel. To get all these results in your forgings, always specify Timken forging steels. The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

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